USER'S MANUAL 990-922
Revision B September 2012

ADVANCED DUAL PULSE
STORED ENERGY
RESISTANCE WELDING POWER SUPPLIES

Model	Stock No.
125ADP/115/230	1-305-01
300ADP/115/230	1-296-01
1000ADP/115/230	1-297-01

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Revision Record

Revision	EO	Date	Basis of Revision
A	42027	6/12	None. Original edition.
B	42170	9/12	Add Repeat Mode function and 125ADP Ws programming in 0.1 Ws increments.

Your New ADP Welder Shipment Contains The Following Items:

1. The ADP unit.
2. User manual # 990-922.
3. Ship Kit # 4-81179-01.
4. External current coil (1000ADP only).

NOTE: The **1000ADP** will also have an external transformer shipped on a separate pallet.

Ship Kit Contents

Ship Part Number 4-81179-01

Part Number	Description	Quantity
205-129	Power Cord, 115 VAC	1
245-162	Backshell, 37 pin D-sub	1
250-409	D-sub, 37 pin connector	1

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CONTACT US

Thank you for purchasing a Miyachi Unitek™ Resistance Welding System Control.

Upon receipt of your equipment, please thoroughly inspect it for shipping damage prior to its installation. Should there be any damage, please immediately contact the shipping company to file a claim, and notify Miyachi Unitek at:

1820 South Myrtle Avenue
P.O. Box 5033
Monrovia, CA 91017-7133
Telephone: (626) 303-5676
FAX: (626) 358-8048
e-mail: info@unitekmiyachi.com

The purpose of this manual is to provide the information required for proper and safe operation and maintenance of the Miyachi Unitek™ 125ADP/300ADP/1000ADP Dual Pulse Resistance Welding Power Supplies.

We have made every effort to ensure that information in this manual is both accurate and adequate. If you have any questions or suggestions to improve this manual, please contact us at the phone number or addresses above.

Miyachi Unitek Corporation is not responsible for any loss or injury due to improper use of this product.

SAFETY NOTES

DANGER

- **DEATH ON CONTACT** may result if you fail to observe all safety precautions. ***Lethal voltages*** are present in the Power Supply.
- ***Never*** perform any welding operation without wearing protective safety glasses.

This instruction manual describes how to operate, maintain and service the 125ADP/300ADP/1000ADP Dual Pulse Resistance Welding Power Supplies, and provides instructions relating to its *safe* use. A separate manual provides similar information for the weld head used in conjunction with the power supply. Procedures described in these manuals *must* be performed, as detailed, by *qualified* and *trained* personnel.

For *safety*, and to effectively take advantage of their full capabilities, please read these instruction manuals before attempting to operate weld heads and power supplies.

Procedures other than those described in these manuals or not performed as prescribed in them, may expose personnel to electrical shock or burn hazards.

After reading these manuals, keep them for future reference.

Please note the following conventions used in this manual:

WARNING: Comments marked this way warn the reader of conditions which might result in *immediate death or serious injury*.

CAUTION: Comments marked this way warn the reader of conditions which might result in damage to the equipment.

Declaration of Conformity

Application of Council Directive: 89/336/EEC

Standards To Which Conformity Is Declared:	**EN61326: 1998** **EN55011 Class A Group 1** **EN61000-4-2** **EN61000-4-3** **EN61000-4-4** **EN61000-4-5** **EN61000-4-6** **EN61000-4-8** **EN61000-4-11**
Manufacturer's Name:	**Miyachi Unitek**
Manufacturer's Address:	**1820 S. Myrtle Avenue** **Monrovia, CA 91016** **626-303-5676**
Equipment Description:	**Dual Pulse Welder**
Equipment Class:	**Laboratory, Measurement, & Process Control Equipment: Industrial Environment**
Model Numbers:	**300ADP** **(Inclusive of 125ADP, 100ADP)**

I the undersigned, hereby declare that the equipment specified above, conforms to the above Directive(s) and Standard(s).

Monrovia, CA, USA
Place:
Thomas Houy
Signature:
Thomas Houy
Full Name:
Mgr, Sustaining Engineering
Position:

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30 Jun 2008
RV88076A-001

Declaration of Conformity

Application of Council Directive: 2004/108/EC

Standards To Which Conformity Is Declared:

EN61326-1:2006

EN55011 Class A Group 1
EN61000-4-2
EN61000-4-3
EN61000-4-4
EN61000-4-5
EN61000-4-6
EN61000-4-8
EN61000-4-11

Manufacturer's Name: Unitek Miyachi

Manufacturer's Address: 1820 S. Myrtle Avenue
Monrovia, CA 91016
(626) 303-5676

Equipment Description: Welder

Equipment Class: Electrical Equipment Measurement, Control & Laboratory Use

Model Numbers: 1000ADP

I the undersigned, hereby declare that the equipment specified above, conforms to the above Directive(s) and Standard(s).

Place: Monrovia, CA USA

Signature: David Cielinski

Full Name: DAVID CIELINSKI

27 JAN 2010

CHAPTER 1
Description

Section I: Features

Features

Miyachi Unitek **125ADP/300ADP/1000ADP Dual Pulse Resistance Welding Power Supplies** precisely control welding energy and weld head timing. For the rest of this manual, the **ADP Dual Pulse Resistance Welding Power Supply** will simply be called ***the Power Supply***.

The 125ADP and 300ADP contain the same set of control features. The 1000ADP has all of the features of the ADP product family except the polarity is fixed and not user settable in weld schedules. In addition, the pulse width is not user settable in weld schedules. Both the polarity and pulse width are set in the 1000ADP at the Factory prior to shipment.

- Multi-function **microprocessor control** facilitates multiple applications at a single work-station and is compatible with both manual and air actuated weld heads. The Power Supply provides repeatable process control and protection from weld schedule changes by unauthorized personnel.
- **Dual pulse welding** can eliminate weld splash and improve weld quality, especially when welding plated materials.
- A **peak current monitor** displays actual peak current delivered to the weld on each pulse.
- User programmable **monitor limits** on each pulse can help to detect poor welding conditions. Programmable test pulses in conjunction with the **INHIBIT SECOND PULSE** feature can inhibit welding when conditions are out of limits on the test pulse.

- The **upslope** feature improves welding when parts are oxidized, surfaces are contaminated, or parts do not mate well.
- **Alternating polarity** allows the user to program pulse polarity changes each time the welder is fired. This allows the user to equalize the wear between two electrodes in many parallel gap welding processes. (This feature is not present in the 1000ADP)
- Five **relays** provide rear panel output signals for **UNIT READY TO WELD, WELD COMPLETED, WELD OUT OF LIMITS, ALARM,** and **WELD COUNTER PRESET LIMIT.**

- Two **air valve drivers** are provided for sequential control of two separate air operated weld heads, when desired. As shipped, Air Valve Driver 2 is configured for 24 VAC weld head operation, but may be reconfigured for 24VDC compatibility when required. See *Appendix B, Electrical & Data Connections* for details on how to make this conversion. Air Valve Driver 1 is ***only*** compatible for 24VDC.
- Remote schedule selection **simplifies use in automated systems**. The **CONTROL SIGNALS** connector provides remote control capability for **EMERGENCY STOP**, **REMOTE WELD INHIBIT**, and **REMOTE WELD SCHEDULE SELECTION**.
- The **CHAIN SCHEDULE** feature allows consecutive schedules to be chained together.
- An **advanced charging circuit** provides rapid recharging and greater throughput.

Display Screens

Large, remarkably intuitive screens, allow the user to see everything at a glance. See *Chapter 3, Using Display Screens* for complete instructions. Briefly, the **RUN** screen is **BLUE**, welds within limits display **GREEN**, and welds out of limits display **RED** as indicated below.

Pulse 1 & Pulse 2 Limits OFF

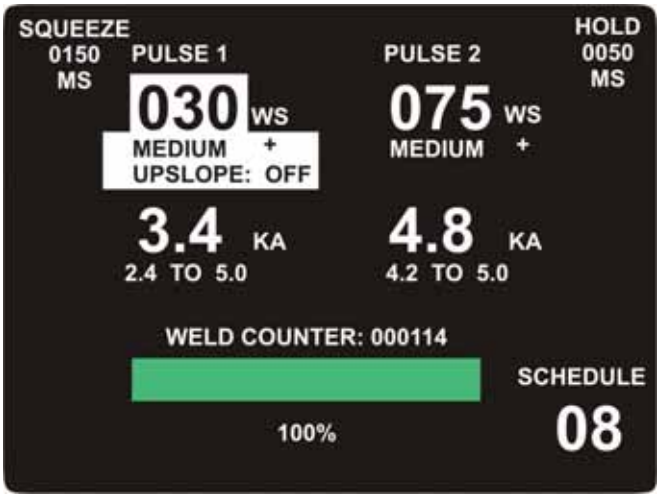
Pulse 1 Out of Limits / Pulse 2 Within Limits

To "edit" **RUN**, **MENU** , or **LIMITS / COUNTERS** screens, press the appropriate **PULSE 1, PULSE 2, SQZ/HOLD, LIMITS/COUNTERS** or **MENU** button until the screen changes to **BLACK** indicating you've entered "edit" mode.

Highlight the item being edited in white as shown at the right. Edit values using the ▲▼(up/down) arrows keys, then advance to the next field.

When finished, press the **SAVE** button, which will "save changes" and return the display to the **BLUE** run mode screen. You're ready to weld!

NOTE: If you edited the limits screen, you will need to press **RUN** after **SAVE** to enable the weld mode.



See *Chapter 3, Using the Display Screens* for details on using these features.

- The schedule lock feature restricts welding to the one selected weld schedule and prevents changing that schedule.
- The program lock feature allows the use of all 63 schedules, but does ***not*** allow editing schedule values.
- The digital display allows operators to set welding energy accurately and quickly.
- The Power Supply is compatible with both manually and air actuated weld heads with 1-level or 2-level foot switches.
- The Power Supply is compatible with force fired and non-force fired weld heads. **SQUEEZE** and **HOLD** delay times are adjustable from **0** to **2.999** seconds.
- A built-in weld counter allows controlling events based on number of welds completed. The counter limit provides an output signal when the count equals or exceeds the user-programmable value.
- The firing circuit is compatible with single pole, double pole or optical firing switches.
- The energy monitor and lockout prevent poor welds caused by premature firing of the power supply before the capacitor bank has been properly charged or discharged.
- The line failure turndown safety feature discharges the capacitor bank when input power is interrupted.
- The Power Supply is protected from radio frequency and electromagnetic interference, resulting in reliable operation even in high electrical noise environments. Input switch debounce circuitry eliminates false triggering.

Detailed instructions on using these features are located in *Chapter 4, Operating Instructions.*

Description

The 125, 300, and 1000 Watt-second, stored energy, capacitor discharge, dual pulse power supplies are versatile and can effectively solve most precision, small part resistance welding problems.

Up to 63 weld schedules can be programmed and saved into memory. A built-in schedule protection feature protects weld schedules from unauthorized or inadvertent changes. The exclusive charge monitor and firing lockout features guaranteed accurate energy output independent of line voltage fluctuations and / or process speed.

Dual pulse welding improves weld quality and can eliminate weld splash. *Dual pulse* means each weld is performed with two pulses with independent energy levels and independent polarity. When welding parts with plating or contamination the first pulse can be used to consistently seat the electrodes onto the part surfaces. The second pulse welds the base metals.

The remote schedule feature allows the weld schedules to be selected in automated applications.

ADP Power Supplies are designed to operate at either 100-120VAC or 200-240VAC, 50/60 Hz and can be used with manual, user actuated, or air actuated weld heads.

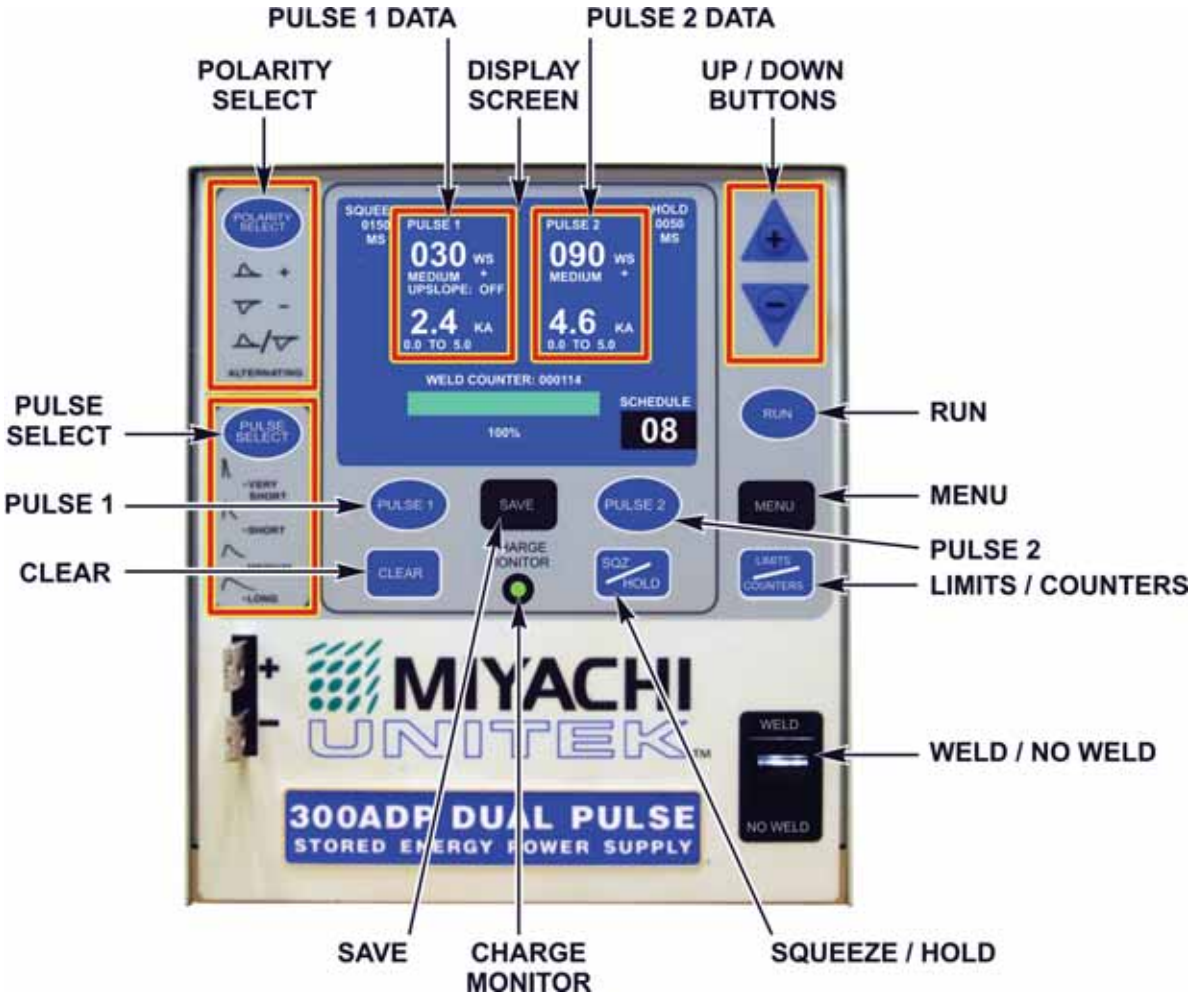
Section II: Major Components

Major Components

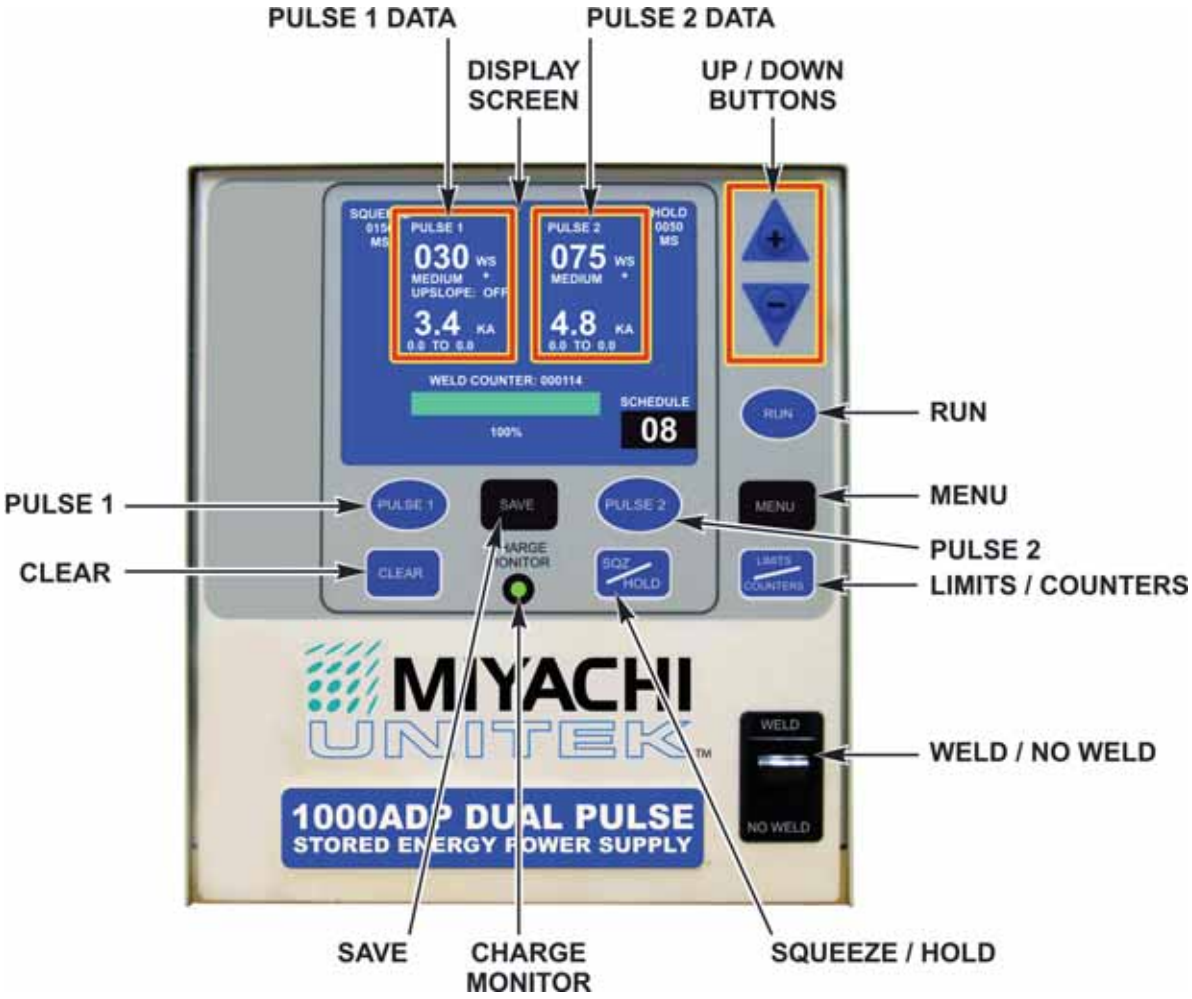
The major components are the front panel, which contains operator controls and indicators, and the rear panel, which contains fuses, circuit breakers, power and signal connectors. The rear panel connections are discussed in *Chapter 2, Installation and Setup*.

Front Panel Controls

The function of each item is described on the following pages.

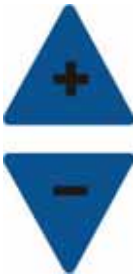


Front Panel Controls (125ADP, 300ADP)



Front Panel Controls (1000ADP)

UP/DOWN Buttons



The UP (+) and DOWN (−) buttons have two functions.

- During "normal" operation, up and down buttons are used to scroll through the 63 schedules to select a desired schedule. The schedule number displays at the lower right corner of the front panel display screen.
- In "editing" mode, these buttons also are used to increase or decrease highlighted values.

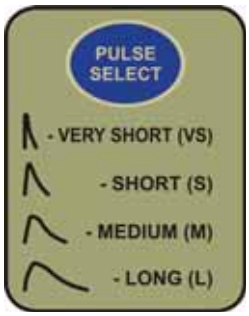
Polarity Select

This button is ***only*** active when the Power Supply is in the "editing" mode. Press this button repeatedly until the polarity you want displays adjacent to the Pulse 1 or Pulse 2 3-digit energy display.

For example, the front panel display screen shown on the previous page, indicates positive (**+**) polarity selected for both Pulse 1 and Pulse 2.

Note: This button is not present on the 1000ADP

Pulse Select



This button is ***only*** active when the Power Supply is in the "editing" mode. Press this button repeatedly until the pulse duration you want is indicated directly below the 3-digit energy display. The front panel display screen shown on the previous page, indicates **MEDIUM UPSLOPE** pulse duration selected for Pulse 1 and **MEDIUM** pulse duration selected for Pulse 2.

NOTE: The **VERY SHORT** setting provides the shortest duration for a given energy setting. The **SHORT** setting will provide the highest peak current for a given energy setting. The **LONG** setting will provide the lowest peak current and longest duration for a given energy setting.

Note: This button is not present on the 1000ADP

RUN

Pressing the **RUN** button causes the **BLUE RUN** screen (shown on the previous page) to be displayed. Welding is allowed ***only*** when the **BLUE RUN** screen is displayed.

MENU

Pressing this button momentarily causes the **Menu** screen to be displayed. Press and hold this button for 1 second to display the **Menu** editing screen. Welding is ***not*** allowed when these **Menu** screens are displayed. Additional instructions for the **Menu** screen are in *Chapter 3, Using Display Screens.*

LIMITS / COUNTERS

Press this button momentarily to display the **Limits / Counters** screen. Press and hold this button for 1 second to display the **Limits / Counters** editing screen. Welding is ***not*** allowed when these screens are displayed. Additional instructions on using the **LIMITS / COUNTERS** screen are in *Chapter 3, Using Display Screens.*

Pulse 1 & Pulse 2

Press and hold either of these buttons for approximately 1 second to put the unit into "edit" mode which allows modification of weld schedule settings.

Press and hold the **Pulse 1** button, waiting for the screen background to change from **BLUE** to **BLACK**. Energy, pulse width, and polarity for Pulse 1 may now be edited. To accept changes, press the **SAVE** button. To exit "editing" mode ***without*** accepting changes, press the front panel **RUN** button, then at the **SAVE** prompt, press the **CLEAR** button to discard.

To edit **Pulse 2** parameters, follow the same procedures described for Pulse 1.

SQZ / HOLD

Pressing this button during edit mode causes the editing highlight to move to the **SQUEEZE** field.

Pressing this button again moves the highlight to the **HOLD** field.

SAVE

Pressing this button saves changes made during editing. Press this button before turning the unit OFF in order to save **Weld Counter** values and the most recent weld schedule data.

CLEAR

Press this button to clear the **SQUEEZE**, **HOLD**, **WELD COUNTER**, **COUNTER LIMIT**, **PULSE 1 & PULSE 2 UPPER & LOWER LIMIT** fields. Pressing this button discards changes made during editing at the **SAVE** prompt: Press **SAVE** to save changes **CLEAR** to discard.

CHARGE MONITOR Light

When the green **CHARGE MONITOR** light is lit, capacitors are fully-charged and ready to weld. The light will turn off for a short time during the weld discharge period and while the capacitor bank is recharging. Once capacitor charging has been completed, the **CHARGE MONITOR** light will again illuminate. When the **WELD/NO WELD** switch is in the **NO WELD** position, the **CHARGE MONITOR** light will ***not*** light because the system is not ready to weld.

WELD/NO WELD Switch

With the **WELD** switch is in the **WELD** position, weld current is enabled and programmed weld sequences execute normally.

With the **WELD** switch to the **NO WELD** position, weld current is **INHIBITED and output relays are disabled**; however, all other control functions execute in a normal manner. This feature allows adjustment of weld head and **SQUEEZE / HOLD** delay parameters prior to actual welding.

Emergency Stop Switch Operation

If your work station has an **EMERGENCY STOP SWITCH**, connect it to the cable provided at the rear panel of the unit. When pressed, the **EMERGENCY STOP SWITCH** will immediately halt the welding process and de-energize all air valves and power circuits. Additionally, an **EMERGENCY STOP** status display message will appear near the bottom of the display screen. To resume operation, reset the **EMERGENCY STOP SWITCH** to the normal position which will automatically return the system to **RUN** mode.

NOTE: During the 20-second startup period when the Power Supply is first turned ON, an activation of the Emergency Stop will interrupt 24V power to the Air Valve Driver output to ensure the weldhead is ***not*** actuated. When the 20-second startup period is completed, the **EMERGENCY STOP** message will be displayed and the buzzer will sound.

If your work station is not equipped with an **EMERGENCY STOP SWITCH**, be sure that the conductors of the emergency stop input cable are shorted together as the system will not operate with this loop electrically open.

CHAPTER 2
Installation and Setup

Section I: Installation

Unpacking

When you unpack the shipping container, be sure that the contents of the shipping kit match the list in *Appendix A, Technical Specifications* and that you have also received the accessories you ordered.

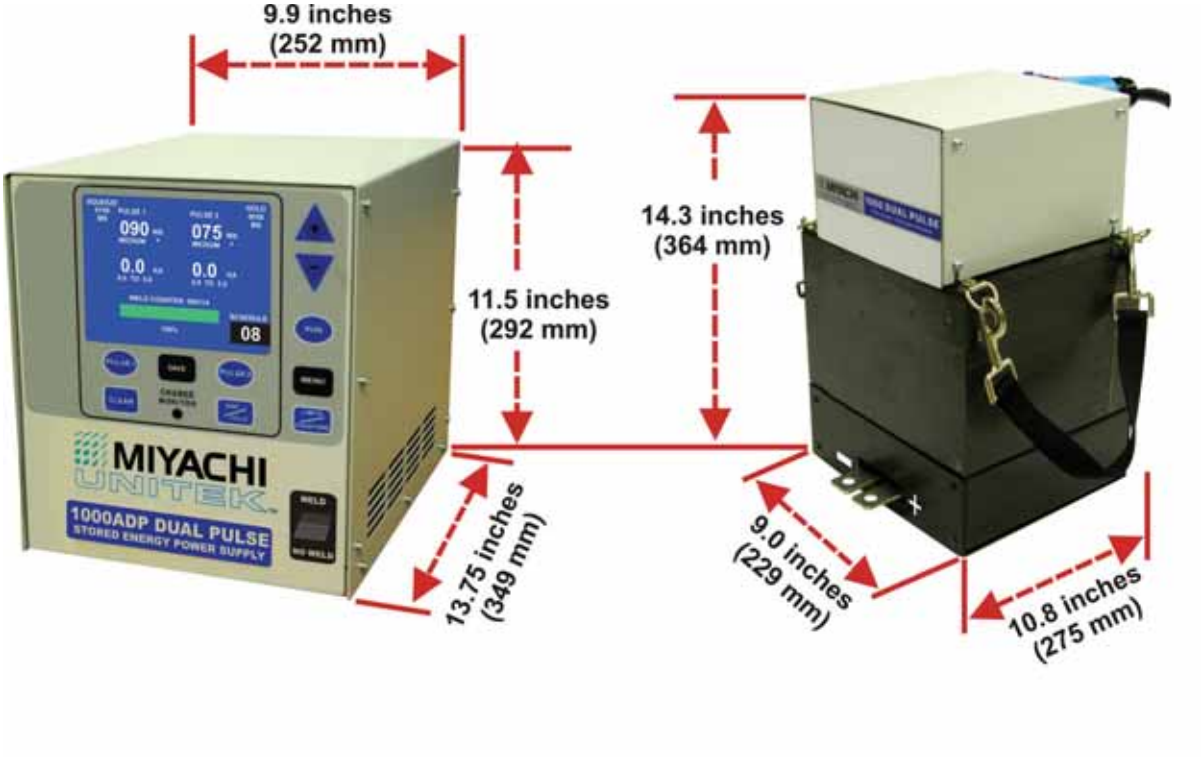
If the Power Supply shows any signs of shipping damage, promptly contact both the carrier and Miyachi Unitek Customer Service. See **CONTACT US** in the front of this manual to get in touch with us by e-mail, telephone, or regular mail.

Space Requirements

- Allow ample workspace around the Power Supply so that it will not be impacted during operation.
- Allow sufficient clearance around the sides and back of the Power Supply to allow for connecting cables.
- Allow enough ventilation space so the Power Supply does not overheat.
  - **125ADP & 300ADP:** Allow 1 inch space on each side, 2 inches of space in the rear.
  - **1000ADP:** Allow 1 inch space on each side, 2 inches of space in the rear.
  - **1000ADP Weld Transformer:** Allow 1 inch on all sides of the transformer

- The work surface must be level, stable, free from vibration, and capable of supporting the combined weight of all system components. Weights are listed in *Appendix A, Technical Specifications*.
- Locate the Power Supply at a sufficient distance from weld heads so as to avoid weld splash.
- Locate the Power Supply at a sufficient distance from sources of high-frequency radiation to avoid electrical interference.
- The work area must be free of excessive dust, acids, corrosive gases, salt and moisture.

NOTE: Unlike the **125ADP** and **300ADP** Power Supplies which have internal transformers, the **1000ADP** has a large, external transformer that must be located within 2 meters of the power supply.



Utilities

Power

The Power Supply is shipped with a universally compliant power cable and a North American compliant 115VAC three prong connector. For operation in countries with different AC mains requirements, remove the male three prong mains connector and replace it with an approved mains power connector for the country in which the unit is to be used. The required connections for your power cable connector are described in *Appendix B, Electrical and Data Connections.* Input power requirements for the Power Supply are as listed below.

Power Input Specifications

Model	Input Voltage, 50-60 Hz, Single phase (Vrms)	Circuit Breaker Current (A rms)	Copper Wire Gauge, 7 strands (AWG)	Wire Diameter (mm)
125ADP, 300ADP, 1000ADP	100-120	15	10	2.5
125ADP, 300ADP, 1000ADP	200-240	10	10	2.5

Compressed Air and Cooling Water

If compressed air or cooling water service is required for the weld head, please refer to the weld head manufacturer's user manual for service specifications.

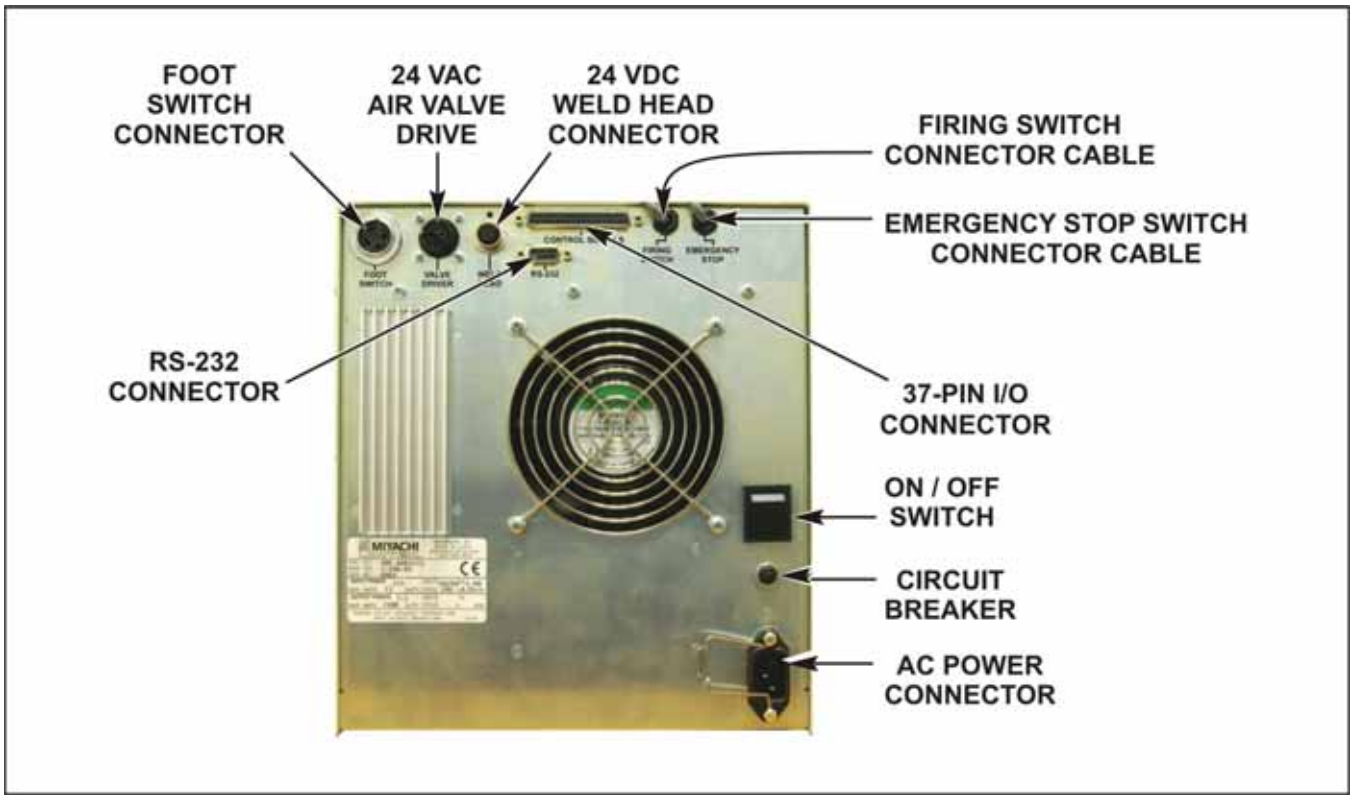
Input Logic Configuration

The unit is shipped from the factory configured for **LOW = TRUE INPUTS** which is compatible with switch closures to ground for activation, or to enable an input function ON. The unit can also be configured for **HIGH = TRUE INPUTS** which is commonly used with a PLC or other external device which supplies +24VDC to activate, or to enable inputs ON.

Detailed instructions for changing the Input Logic Configuration, including electrical schematics, will be found in *Appendix B, Electrical and Data Connections*.

Section II: 125ADP & 300ADP External Equipment Connections

All connections between the Power Supply and external equipment other than the weld cable are made through the rear panel.



Rear Panel Components and Connectors 125ADP and 300ADP

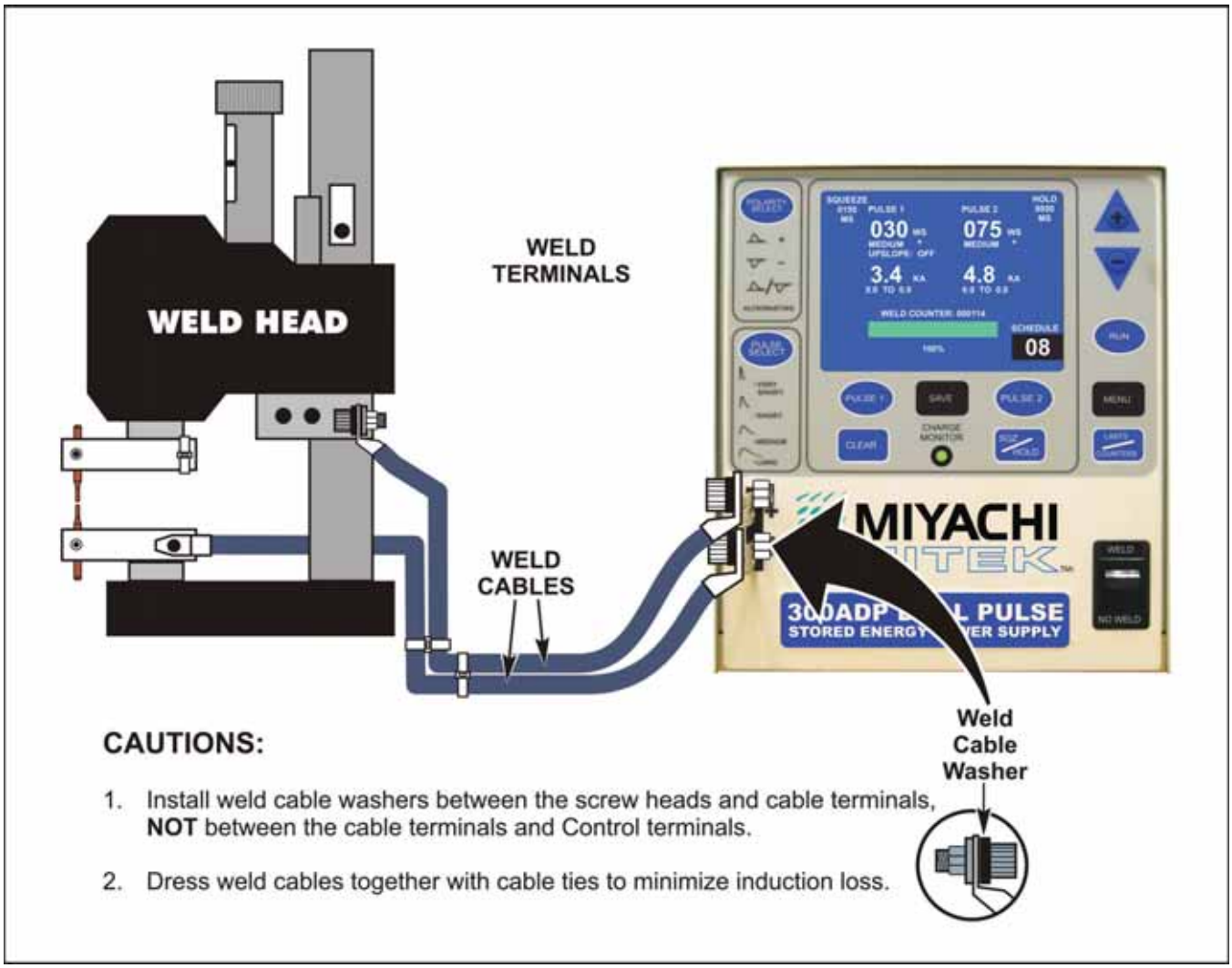
NOTE: Weld cable connections are made at the front panel for the 125ADP and 300ADP Power Supplies and located on the front panel of the external transformer on the 1000ADP systems.

Emergency STOP Switch

Connect an agency compliant, normally closed, **EMERGENCY STOP SWITCH** across the two leads of the emergency stop switch connector cable. This switch, when operated (open), will immediately stop the weld cycle. See *Appendix B. Electrical and Data Connections* for circuit details.

NOTE: For operation ***without*** an **EMERGENCY STOP SWITCH**, verify that the two conductors of the emergency stop cable are shorted together as the system will not operate with this loop electrically open.

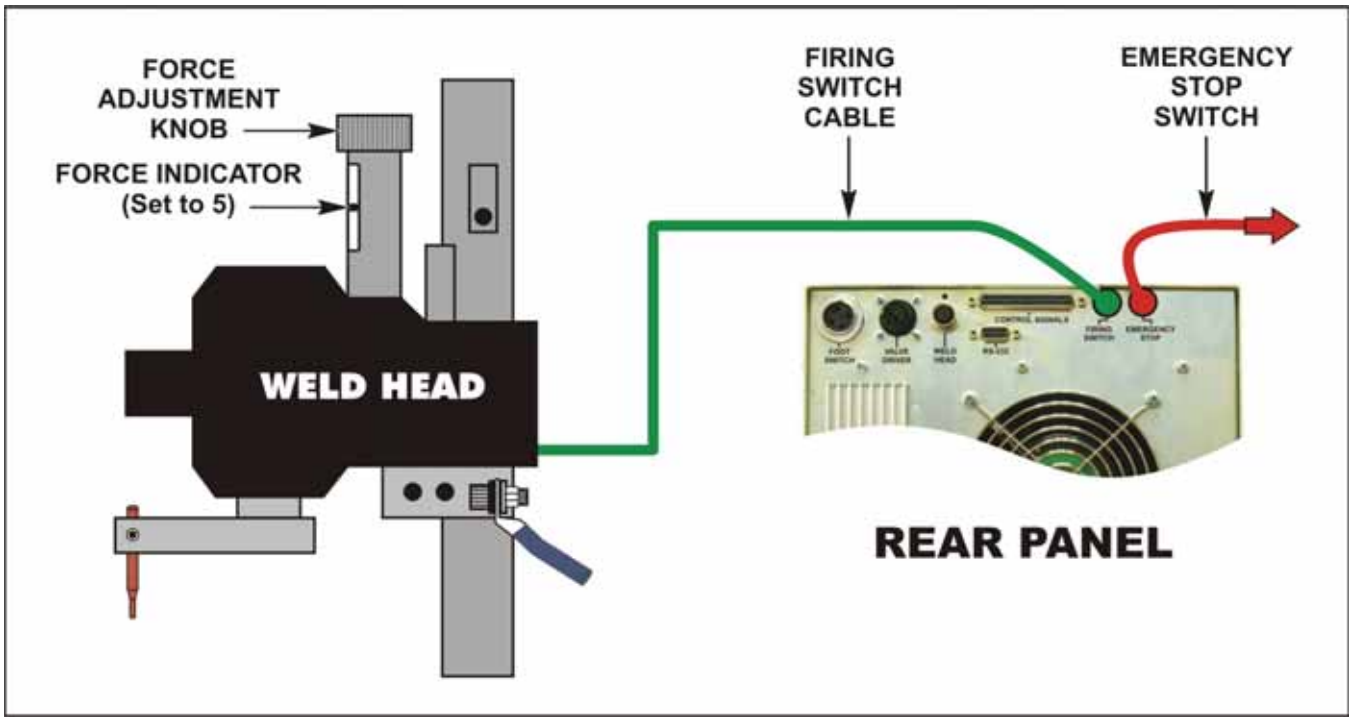
Weld Head Connections to Power Supply Terminals


WELD HEAD
WELD TERMINALS
WELD CABLES
MIYACHI
Weld Cable Washer
CAUTIONS:
1. Install weld cable washers between the screw heads and cable terminals, NOT between the cable terminals and Control terminals.
2. Dress weld cables together with cable ties to minimize induction loss.

1. Turn the AC power turned OFF.
2. Connect one end of a weld cable to the negative (**-**) welding transformer terminal on the Power Supply (or external transformer for a 1000ADP).
3. Connect one end of the second weld cable to the positive (**+**) welding transformer terminal on the Power Supply (or external transformer for a 1000ADP).
4. Connect the other end of the weld cables to the weld head.
5. Install electrodes in the weld head electrode holders.

   NOTE: If you need additional information about the weld heads, please refer to the manufacturer's user manuals.

Foot Pedal-Actuated Weld Head

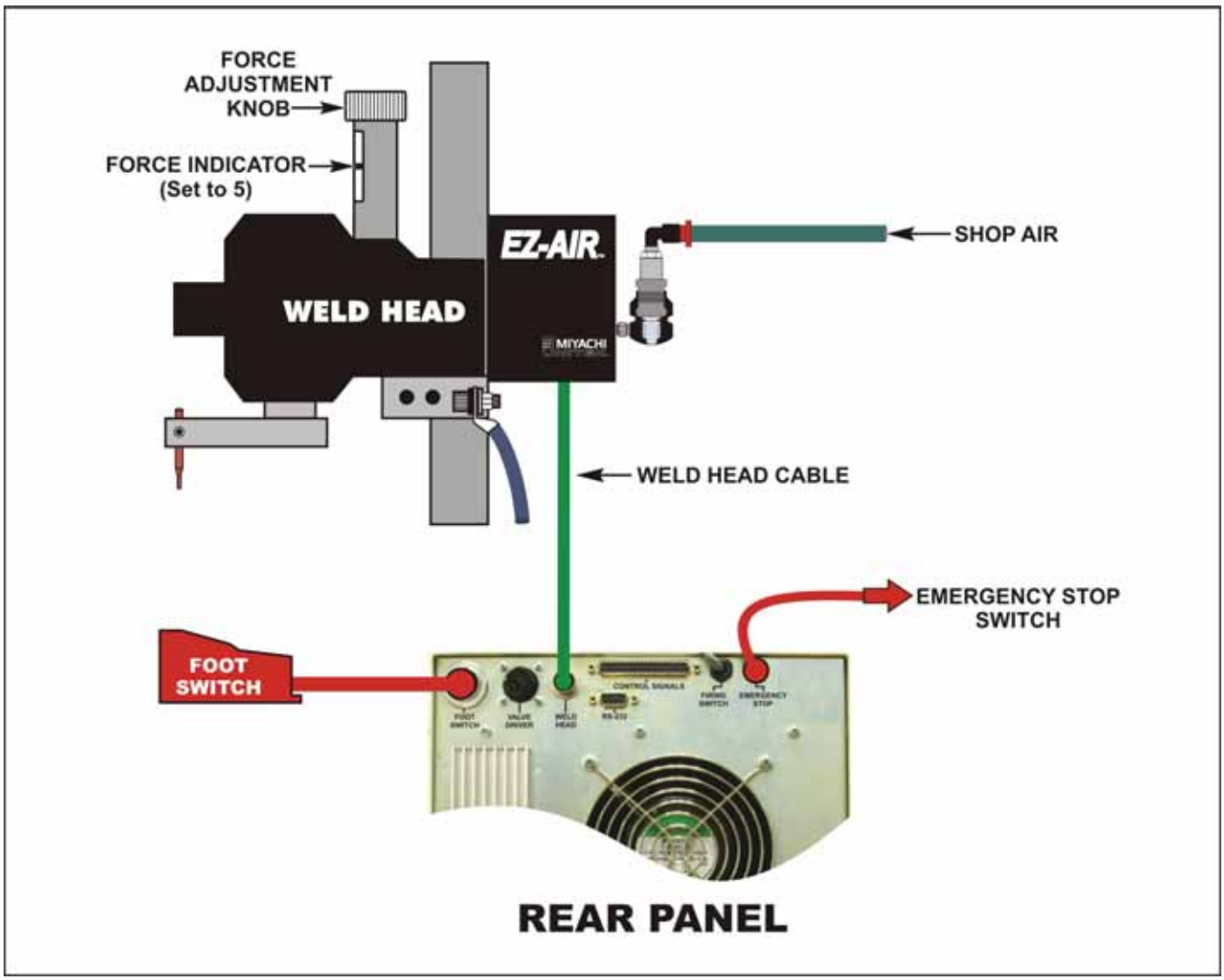


1. Adjust the weld head force adjustment knob to produce **5** units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Power Supply firing switch cable connector.
3. Connect a normally closed, agency compliant, **EMERGENCY STOP SWITCH** across the two leads of the emergency stop switch connector cable. This switch, when operated (open), will immediately stop the weld cycle and retract the weld head. See *Appendix B. Electrical and Data Connections* for circuit details.
4. Set the **ON/OFF** switch on the rear panel of the Power Supply to the **ON** position.
5. Set the active schedule to the minimum energy level of the Power supply.
6. Set the weldhead force to 5 or greater.
7. Smoothly close the weldhead. Verify that the power supply fires.

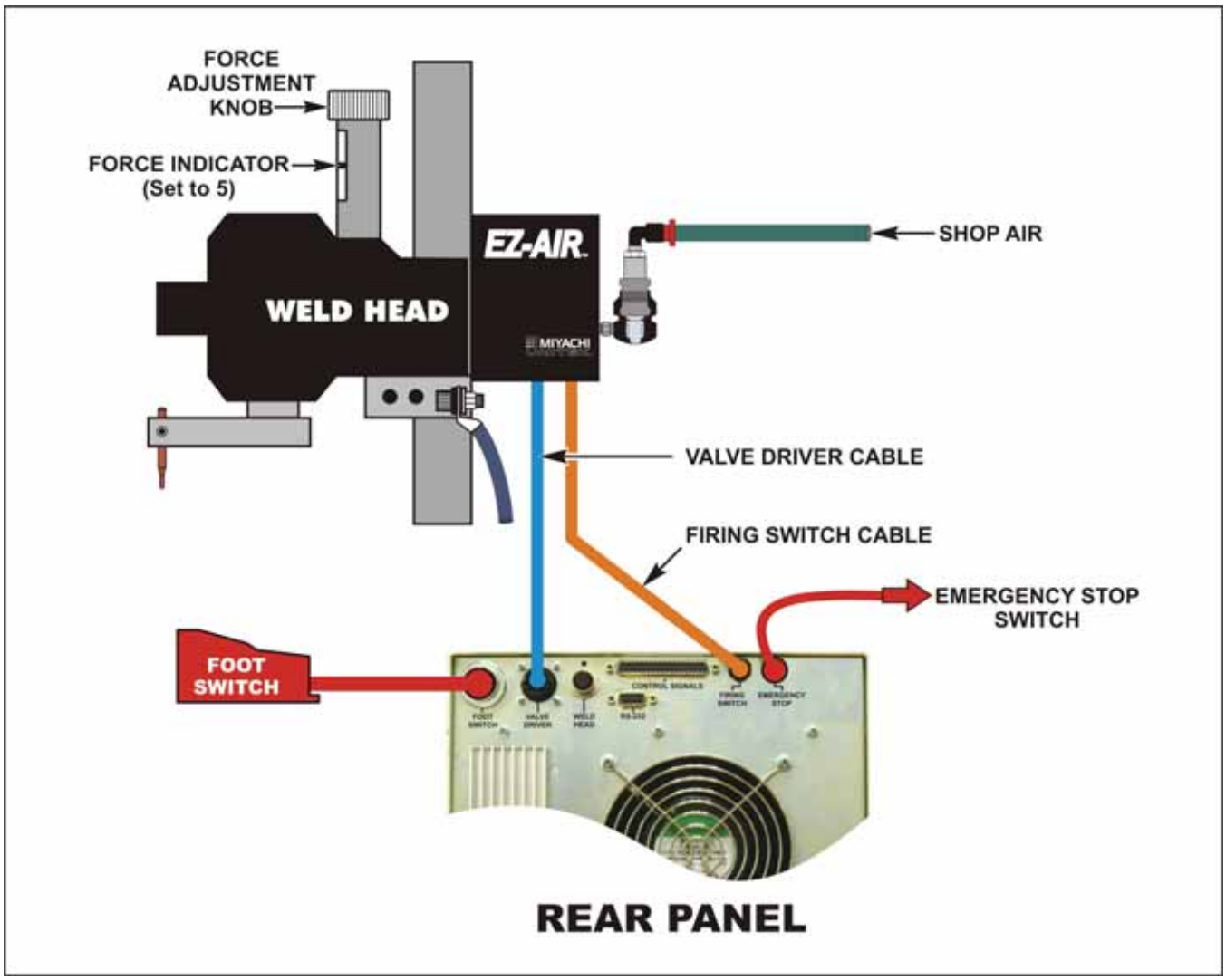
EZ-AIR Weld Head Connections

24 VDC *EZ-AIR*

NOTE: These instructions describe connection to the Miyachi Unitek ***EZ-AIR*** weld head. Non-*EZ-AIR* heads may be connected to the Power Supply but are not covered in these instructions. For non-*EZ-AIR* head instructions, refer to the manual provided by the weld head manufacturer.



24 VAC *EZ-AIR*



NOTE: These instructions are for both 24VDC and 24VAC *EZair* weld heads

1. Adjust the weld head force adjustment knob to produce **5** units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Power Supply firing switch cable connector.
3. Connect a normally closed, agency compliant, **EMERGENCY STOP SWITCH** across the two leads of the emergency stop switch connector cable. This switch, when operated (open), will immediately stop the weld cycle and retract the weld head. See *Appendix B. Electrical and Data Connections* for circuit details.

4. Connect a Model FS2L or FS1L Foot Switch to the Power Supply **FOOT SWITCH** connector.
5. Refer to the weld head manufacturer's User Manual for instructions on connecting the weld head air valve solenoid cable to the Power Supply **AIR VALVE DRIVER** connector.
6. Connect a properly filtered air line to the air inlet fitting on the weld head. Use 0.25 inch O.D. by 0.17 inch I.D. plastic hose with a rated burst pressure of 250 psi. Limit air line length to less than 40 in. (1 m) or electrode motion may be slow.

   NOTES:

   - *EZ-AIR* operates from 85 to 130 psi.
   - Use lubricators ***only*** with automated installations.
7. Turn air system ON and check for leaks.
8. Set the **WELD/NO WELD** switch on the Power Supply front panel to the **NO WELD** position. In this position, the Power Supply cannot deliver weld energy, but it can activate the weld head.
9. Set the ON/OFF switch on the rear panel of the Power Supply to the ON position.
10. Press the foot switch part way to actuate the ***first level*** switch. The weld head upper electrode should descend smoothly to the DOWN position. When it reaches the down position, release the foot switch and proceed to Step 12. If the upper electrode does ***not*** operate smoothly, proceed to Step 11.
11. Adjust the weld head down speed knob and repeat Step 10 until the upper electrode descends smoothly.
12. Press the foot switch all the way down to close both level switches. The weld head upper electrode should descend smoothly to the DOWN position, and then send the firing switch signal back to the Power Supply when the preset electrode force is reached. After firing, the upper electrode should ascend smoothly back to the UP position.

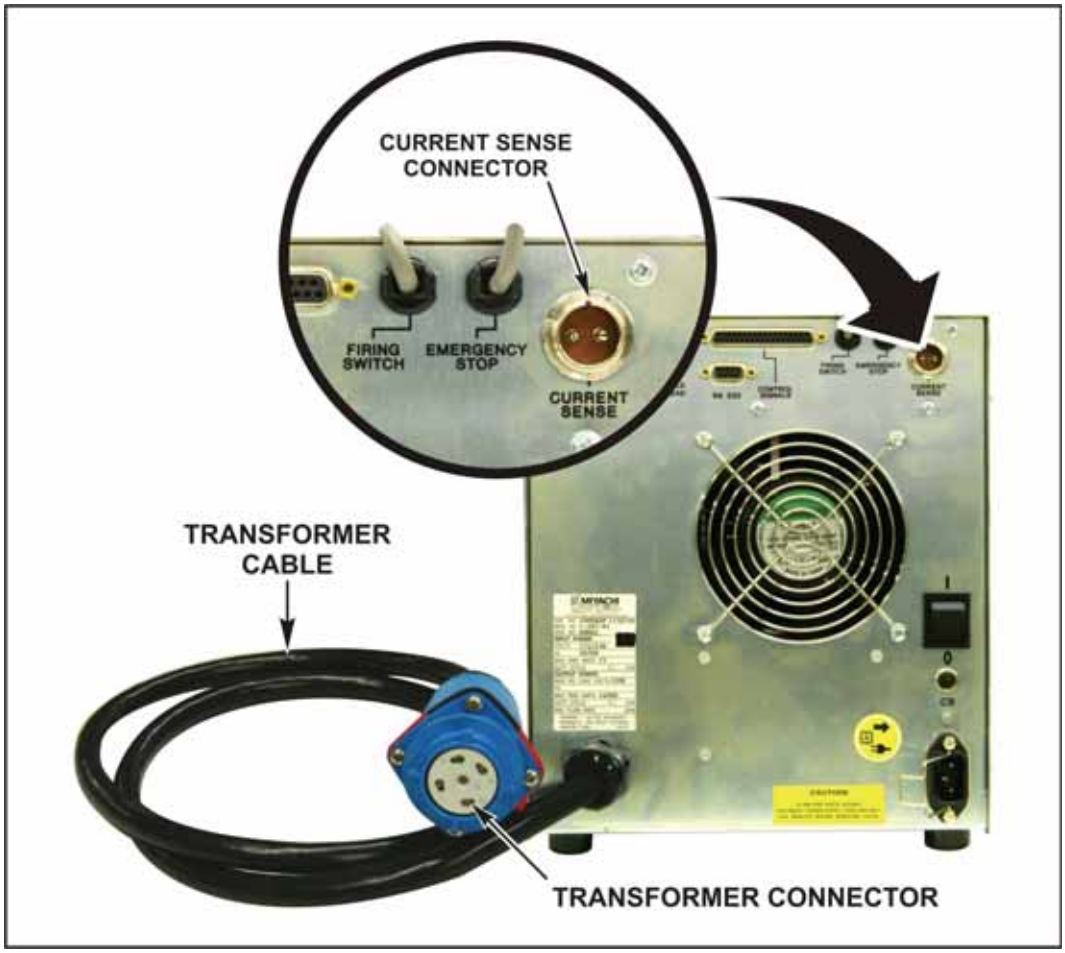
Section III: 1000ADP External Equipment Connections

Overview

Most of the external connections for the **1000ADP** are identical to those for the **125ADP** and **300ADP** described in *Section II,* ***however*** there are two notable exceptions:

- The **1000ADP** uses a separate, external **Weld Transformer**.
- The **1000ADP** uses a separate, external **Current Sense Coil**.

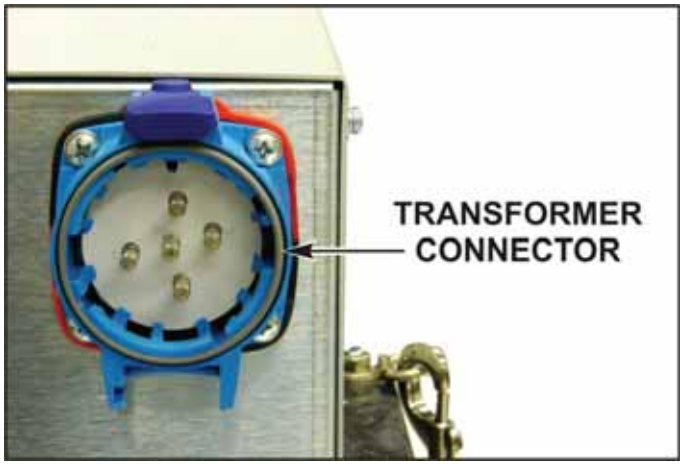
Both of these must be connected to the Power Supply using the rear panel connectors shown below.



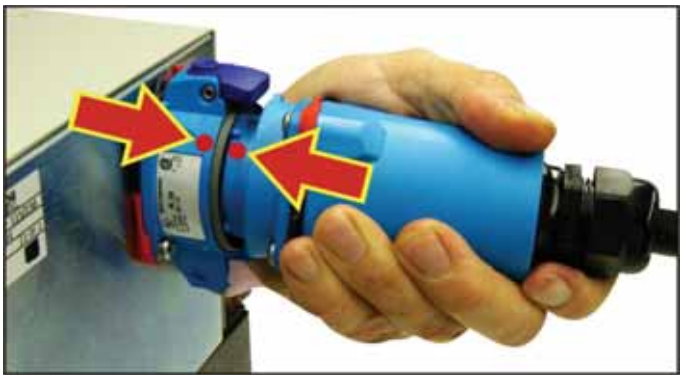
Rear Panel Connectors for the 1000ADP

Connecting the 1000ADP Transformer

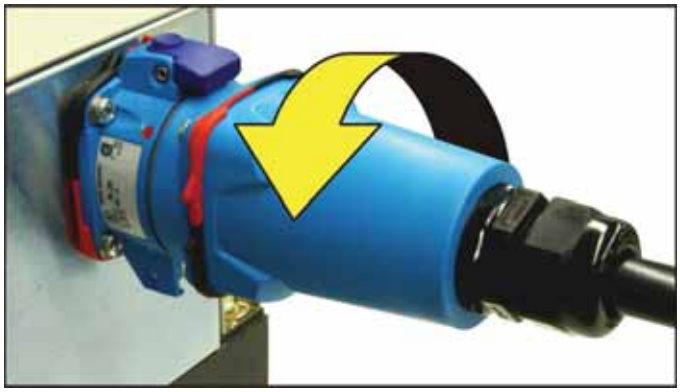
1. Locate the connector at the top rear of the 1000ADP external transformer.

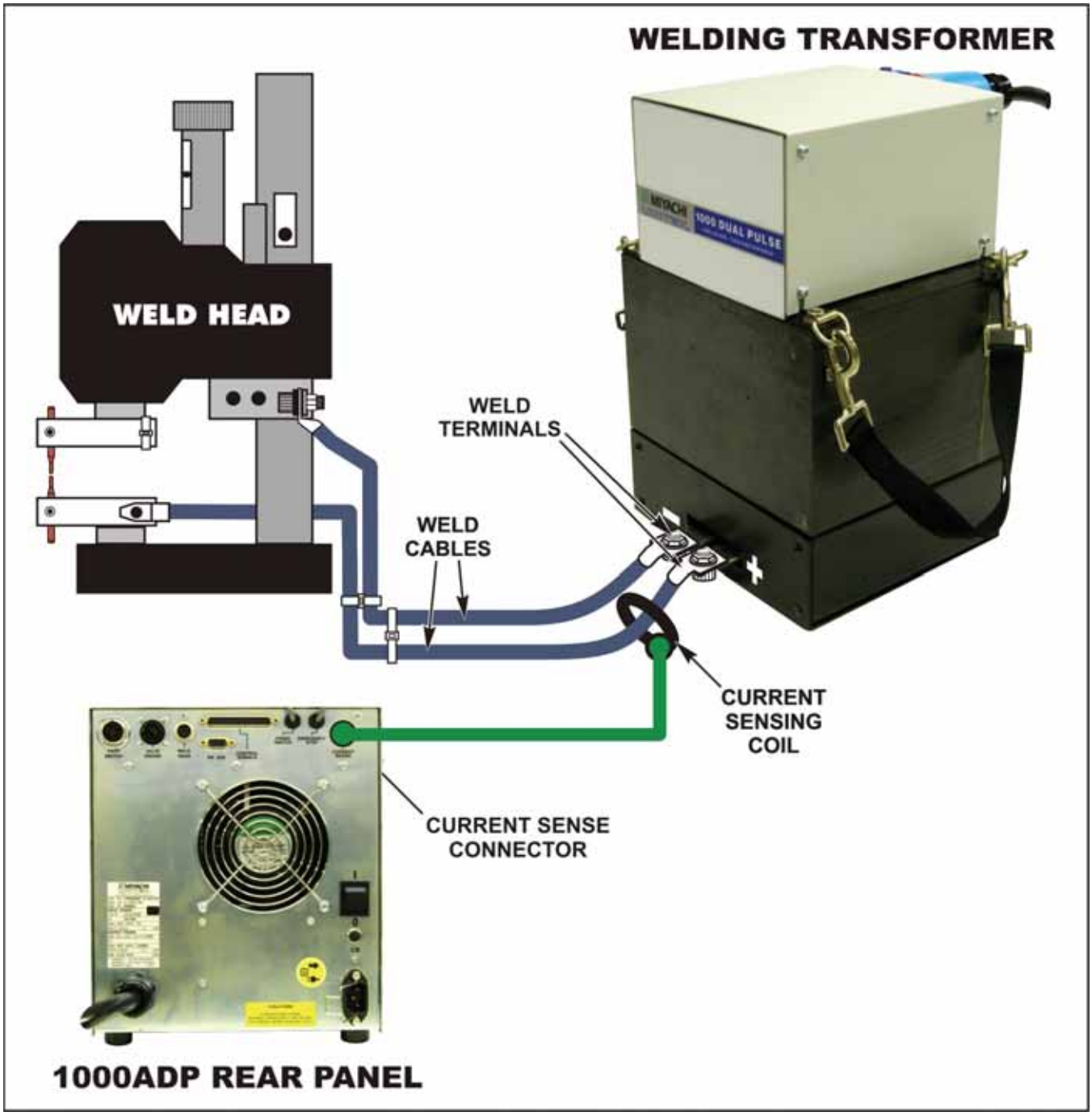


2. Align the **RED** dot on the transformer cable connector to the **RED** dot on the transformer connector.



3. Once the **RED** dots are aligned, push the cable into the transformer connector until it stops, then twist ***counterclockwise*** until the connectors are secured together.





4. Connect the current coil around ***ONE*** of the two weld cables (you can use either the **+** or **–** cable). For best weld monitoring accuracy, use tie-wraps to secure the loop end of the current coil (the end farthest from the opening secured by the Velcro strap) in a fixed position relative to the weld cable.
5. Plug the connector on the current coil cable to the **CURRENT SENSE** connector on the back of the power supply.

CHAPTER 3
Using Display Screens
Section I: RUN Screen

RUN Screen

In the lower middle of the screen the **WELD COUNTER** and process monitor indicate how many welds have been completed since the weld counter was reset and what percentage of those welds were within programmed limits, indicated both numerically and graphically. The **GREEN** bar on the screen above indicates 95% of welds are within limits, the **RED** portion of the bar shows 5% of welds are outside limits.

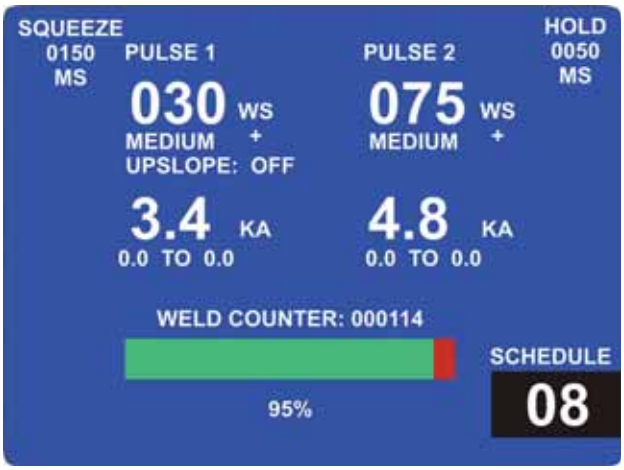
The **BLUE** **RUN** screen is displayed whenever the Power Supply is in **RUN** mode.

Squeeze and hold times are displayed in the upper left and right corners of the screen.

Programmed values for energy, pulse width, weld polarity and upslope are displayed in the upper middle of the screen.

Weld limits, if any, and the peak weld current monitor results for the last weld completed are displayed in the middle of the screen.

The number of the currently active weld schedule is displayed at the lower right corner.



In the lower middle of the screen the **WELD COUNTER** and process monitor indicate how many welds have been completed since the weld counter was reset and what percentage of those welds were within programmed limits, indicated both numerically and graphically. The **GREEN** bar on the screen above indicates 95% of welds are within limits, the **RED** portion of the bar shows 5% of welds are outside limits.

The 125APD allows programmed values for Energy in tenths of watt seconds for energy settings between 1.0 and 10.0 Ws. The energy settings for the 125ADP between 10 and 125 Ws can ***only*** be set in whole number increments.

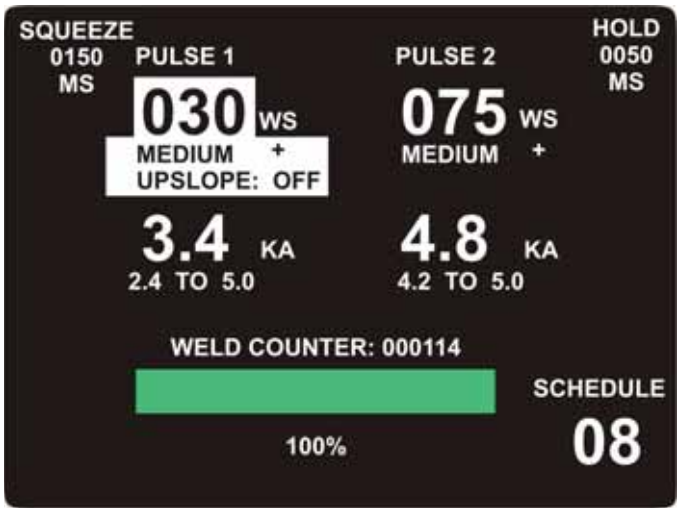
The energy settings for the 300ADP and 1000ADP can ***only*** be set in whole number increments.

The 125ADP **RUN** screen is the same as the 300ADP and 1000ADP **RUN** screens ***except*** the Energy setting is shown with the tenths digit as shown in the screen shown on the right.

Editing the Run Screen

PULSE 1

To edit Pulse 1, pulse width, polarity and upslope settings, press and hold the **PULSE 1** button for about 1 second to highlight the values in **WHITE** as shown on the right.



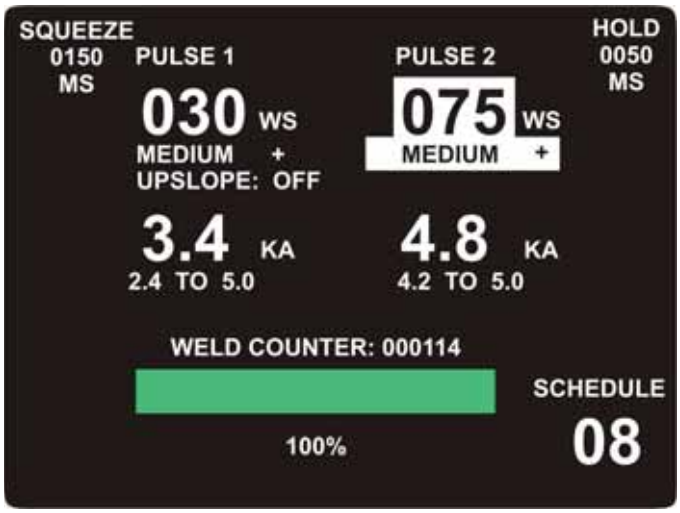
Use the ▲▼ arrows, **PULSE WIDTH** and **POLARITY SELECT** buttons to change the values for Pulse 1.

To change the energy values for Pulse 1, press and hold the **PULSE 1** button for about 1 second, and then use the ▲▼arrows to change the values for Pulse 1.

NOTE: Pulse width and polarity are ***not*** user settable in 1000ADP.

PULSE 2

To edit the same values for Pulse 2, press the **PULSE 2** button and repeat the procedures for Pulse 1.



SQUEEZE TIME

To edit the squeeze time, press the **SQZ/HOLD** button.

HOLD TIME

To edit the hold time, press the **SQZ/HOLD** button again.

Press the **SAVE** button to save new values and return to the original screen.

NOTE: If you have ***not*** edited any values, press the **RUN** button to return to the blue **RUN** screen.

To discard edited values and restore previously saved values, press the **RUN** key. The system will respond with the **SAVE** prompt which appears at the bottom of the screen: "Press **SAVE** to save changes, **CLEAR** to discard." The system will revert to the original screen.

NOTE: Whenever the **RUN, MENU** or **LIMITS/COUNTERS** buttons are pressed ***before*** edited values are saved, the **SAVE** prompt will appear at the bottom of the screen.

Section II: LIMITS / COUNTERS Screen

LIMITS / COUNTERS Screen

Momentarily press the **LIMITS/COUNTERS** button to view the blue **LIMITS/COUNTERS** screen.

Peak current limits for Pulse 1 and Pulse 2 as well as **ACTION** to be taken when Pulse 1 peak current is out of limits are displayed at the middle of the screen.

Values for **WELD COUNTER** and **COUNTER LIMIT** are displayed at the bottom part of the screen

Edit the Limits / Counters Screen

Press and hold the **LIMITS / COUNTERS** button for about 1 second to enter edit mode.

When editing on the **LIMITS / COUNTERS** screen, use the ▲▼ arrows to increment the values of a highlighted parameter.

PULSE 1 – Upper Limit

Press and release the **PULSE 1** button until the upper limit parameter is highlighted. Use the ▲▼ arrows to set the limit to the desired value. Use the **CLEAR** button to enter a value of zero.

PULSE 1 – Lower Limit

Press and release the **PULSE 1** button again until the lower limit parameter is highlighted. Use the ▲▼ arrows to set the desired value.

Use the **CLEAR** button to enter a value of zero.

NOTE: When **UPPER LIMIT** and **LOWER LIMIT** values are both set to zero, the limit function is disabled.

PULSE 2 - Limits

Limits for Pulse 2 are edited in the same manner as previously described for Pulse 1.

PULSE 1 - ACTION

Press and release the **PULSE 1** button until the **ACTION** parameter is highlighted. Use the ▲▼ arrows to select the desired action.

If **ACTION** is set to **CONTINUE**, Pulse 2 will be enabled whether or not Pulse 1 is within limits.

If **ACTION** is set to **INHIBIT PULSE 2**, then Pulse 2 will enabled ***only*** when Pulse 1 is within limits.

RESET WELD COUNTER

From the **LIMITS/COUNTERS** edit screen, press and release the **LIMITS/COUNTERS** button until the weld counter field is highlighted.

Press the **CLEAR** key to clear the weld counter to **000000**.

NOTE: The weld counter value can ***not*** be changed using the ▲▼ arrows.

EDIT COUNTER LIMIT

From the **LIMITS/COUNTERS** edit screen, press and release the **LIMITS/COUNTERS** button until the **COUNTER LIMIT** field is highlighted.

Press the ▲▼ arrows to set a desired limit value or use the **CLEAR** key to reset to the limit to **000000.**

Setting the counter limit to **000000** will disable the **WELD COUNTER RELAY** output signal available at the rear panel **37-PIN I/O CONNECTOR**.

NOTE: At any time before you **SAVE** settings, you may recover original system settings (including the weld counter values) by pressing the **CLEAR** key at the **SAVE 1**. To activate the **SAVE** prompt from the **EDIT** screen, press the **RUN** key and the **SAVE** prompt will now appear. To discard all new settings and values, and return the system to its previous settings, press the **CLEAR** button.

Section II: MENU Screen

MENU Screen

Press the **MENU** button momentarily to display this screen.

Editing the MENU Screen

Press and hold the **MENU** button to enter the **MENU** edit mode. This will highlight the buzzer volume for editing.

To highlight another field, press and release the **MENU** button.

Use the ▲▼ arrows to change the highlighted values in all fields on the **MENU** screen.

BAUD RATE

Press the **MENU** button again the highlight the **BAUD RATE** field. This is the speed used for RS-232 communications.

DEBOUNCE

Press the **MENU** button again for the debounce setting. Use the **0 MSEC** setting for applications where a PLC communicates with the unit.

CHAINING START

Press the **MENU** button again to edit the starting value for a weld chain.

In chaining, all schedules from **CHAINING START** to **CHAINING END** are welded one time and in numeric order. When the last schedule in the chain is completed, the system returns to the **CHAINING START** schedule.

Whenever a schedule within a chain is selected, the chain will start at that schedule. When the last schedule in the chain is completed, the system returns to the **CHAINING START** schedule.

NOTE: If the schedules that are chained together differ in pulse widths or polarities, a delay of 50 to 350 msec may be required between schedules to switch to the new settings.

CHAINING END

Press the **MENU** button again to edit the ending value for a weld chain.

REMOTE

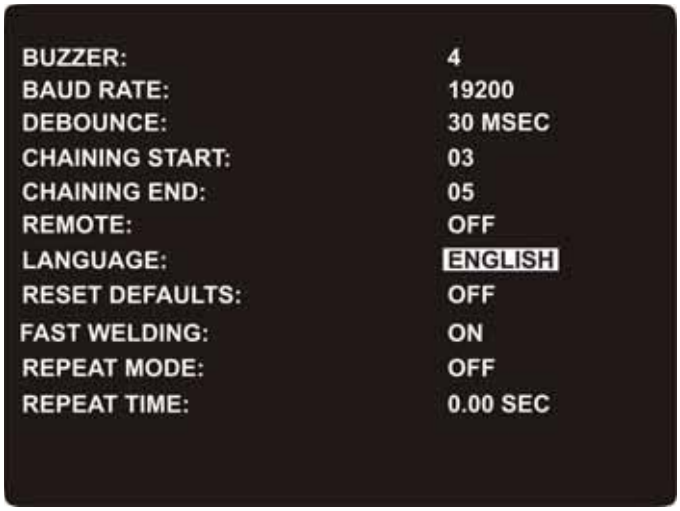
Press the **MENU** button again to highlight the **REMOTE** selection.

When this is set to **OFF**, serial communication commands to read data are active, but commands to change programs and settings are ***not*** active.

When **REMOTE** is set to **ON**, all serial communication commands are active.

LANGUAGE

Press the **MENU** button again to select the language (**ENGLISH, ESPAÑOL, DEUTSCH**). The language on screen will change when this field is saved.



RESET DEFAULTS

Press the **MENU** button again to select the **RESET DEFAULTS**. The default selection is **OFF.**

To set all schedules, limits, weld counter, weld counter limits and all menu items back to their factory default values, select **ON**, then press **SAVE** to save changes.

To discard changes, press **RUN** to activate the **SAVE PROMPT** and at the prompt, press **CLEAR** to discard changes.

After saving or discarding new settings, the display will revert to the original screen selected.

FAST WELDING

Press the **MENU** button again to highlight the **FAST WELDING** selection.

When this is set to **OFF**, weld data is saved to non-volatile memory periodically.

When **FAST WELDING** is set to **ON**, weld data is saved to non-volatile memory only when the user presses the **SAVE** button.

See Chapter 4 for more information about the **FAST WELDING** feature.

REPEAT MODE

Press the **MENU** button again to highlight the **REPEAT MODE** selection. When this is set to **ON**, the control provides an automatic repeat of the weld sequence for simple automated air actuated applications. This weld function is ideal for volume production which requires a single schedule.

REPEAT MODE can ***only*** be used with an Air Actuated Weld Head. On Force Fired Air Actuated Weld Heads, weld current begins when both levels of a two-level Foot Switch are closed and held down and then the Force Firing Switch in the Air-Actuated Weld Head closes sending a fire signal.

When **REPEAT MODE** is used with a Non-Force Fired Air Actuated Weld Head, the Squeeze (SQZ) Period must be used to allow sufficient time for the electrodes to close and apply the required weld force to the parts ***before*** the Weld Period begins. Weld current begins when the Squeeze Period ends and a fire signal is received. During this whole operation ***both*** levels of a two-level Foot Switch must remain closed to continue in **REPEAT MODE**.

When **REPEAT MODE** is used with any type of Air Actuated Weld Head, the Hold Period can be used to automatically keep the electrodes closed on the parts after weld current has terminated to provide additional heat sinking or parts cooling. **REPEAT TIME**, which is applicable only to **REPEAT MODE**, sets the cycling rate between welds by controlling how long the electrodes remain open.

When **REPEAT MODE** is set to **ON**, and the user keeps the footswitch depressed and firing switch closed, the control will repeatedly actuate the weldhead and perform the weld sequence. If set to **ON**, a **REPEAT TIME** other than **0** must also be set.

You should specify the **REPEAT TIME** so that it is sufficient to allow the weld head to open the electrodes and to allow you to reposition the work piece before the entire welding sequence repeats. When **REPEAT MODE** is set to **OFF**, this function is deactivated.

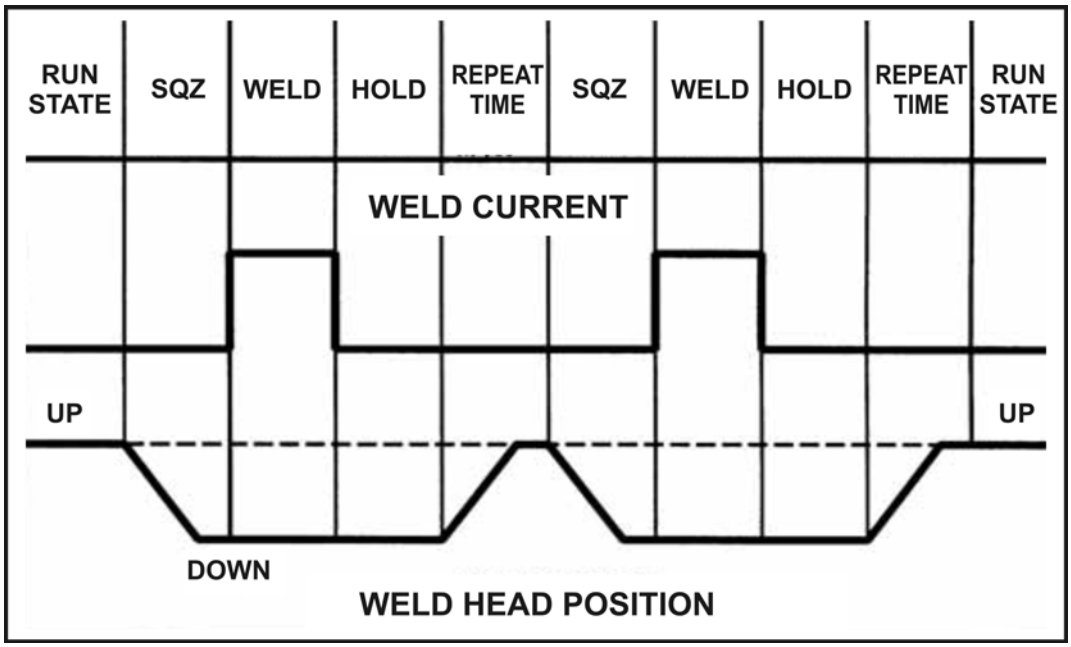
REPEAT TIME

A time other than **0** ***must*** be set if **REPEAT MODE** is set to **ON**.

The **REPEAT TIME** is the time between the end of **HOLD** and the start of the next weld sequence. **REPEAT TIME** can range from **0.25** to **9.99** seconds.

BUZZER:	4
BAUD RATE:	19200
DEBOUNCE:	30 MSEC
CHAINING START:	03
CHAINING END:	05
REMOTE:	OFF
LANGUAGE:	ENGLISH
RESET DEFAULTS:	OFF
FAST WELDING:	ON
REPEAT MODE:	OFF
REPEAT TIME:	0.00 SEC

REPEAT MODE showing REPEAT TIME



CHAPTER 4
Operating Instructions

Section I: Introduction

Before You Start

Before operating the Power Supply, you must be familiar with the following:

- The **location** and **function** of Controls and Indicators. For more information, see *Chapter 1, Description* of this manual.
- How to select and modify items on the Power Supply display screen. Make sure you have read *Chapter 3, Using Display Screens.*
- The principles of resistance welding and the use of programmed weld schedules. For more information, see *Appendix E, The Basics of Resistance Welding.* For additional information on the welding process, see *Appendix F, Quality Resistance Welding Solutions, Defining the Optimum Process*.

Pre-Operational Checks

Always perform these checks ***before*** attempting to operate the Power Supply.

Connections

Verify the Power Supply is connected to a manual or air-actuated weld head as described in *Chapter 2, Installation & Setup* in this manual. Verify the **EMERGENCY STOP SWITCH** connector cable, located on the rear panel, is connected properly.

Power

Verify AC input power is connected as described in *Chapter 2, Installation & Setup* in this manual.

Compressed Air

If you are using an air-actuated weld head, verify that compressed air is connected as described in the appropriate sections of your weld head manual. Turn the compressed air ON**,** and adjust it according to the instructions in your weld head manual.

Initial Setup

1. Set the **WELD/NO WELD** switch on the Power Supply front panel to the **NO WELD** position. In this position, the Unit will operate the weld head ***without*** producing weld current.
2. Set the ON / OFF switch on the rear panel of the Power Supply to the ON position.
3. Adjust the weld head force adjustment knob for a force appropriate for your welding application. A good starting point is the mid-point in the range of the weld head force.
4. Press the foot switch to activate the first level switch and clamp the material. Check the head for suitable clamping pressure. Release the footswitch to release the material. Check the head for smooth operation of the electrodes.
5. When you are ready to perform a weld, be sure to set the **WELD/NO WELD** switch back to the **WELD** position.

Section II. Operation

Start-Up

Turn the Power Supply ON.

Verify that the Start-Up screen displays briefly then changes to the **RUN** screen.

Start-Up Screen and Version Number

Normal RUN Screen

The unit will take approximately 20 seconds to complete its internal startup routine. The **Charge Monitor** indicator on the front panel will turn green when the startup routine has been complete.

Using Existing Weld Schedules

1. Use the ▲▼ arrows to select the weld schedule you desire.
2. Press the **WELD/NO WELD** switch to the **WELD** position.
3. Begin welding using your normal procedures.

   NOTE: Welding will be performed using values of the schedule selected until you select a new schedule.

Modifying Weld Schedules

1. Press the **WELD/NO WELD** switch to the **NO WELD** position.
2. Use the ▲▼ arrows to select the weld schedule you wish to modify.
3. Press the **PULSE 1** button to modify Pulse 1. Hold the button for about 1 second. When the screen changes to black, the Power Supply is in the "edit" mode.
4. To modify the **energy**, press the ▲ arrow to increase energy or press the ▼ arrow to decrease energy.

5. To modify **pulse duration**, press the **PULSE SELECT** button until the pulse length you want is indicated beneath the 3-digit energy display.

   NOTE: The **Very Short** setting provides the shortest duration. The **Short** setting provides the highest peak current for a given energy setting The **Long** setting provides the longest duration and lowest peak current for a given energy setting. The **Medium** setting provide and intermediate option between the **Short** and **Long** settings. Upslope applies to the **Short**, **Medium** and **Long** settings only, and is turned ON or OFF with the **PULSE SELECT** button.

   Note: Pulse duration is not user settable on the 1000ADP

6. To modify **POLARITY**, in edit mode, press the **POLARITY SELECT** button repeatedly until the polarity you want is indicated in the display.

Note: Polarity is not user settable on the 1000ADP

7. To modify the **squeeze time**, press the **SQZ/HOLD** button. The **SQUEEZE** field will be highlighted. Press the ▲ arrow to increase squeeze time or press the ▼ arrow to decrease the squeeze time.
8. To modify the **hold time**, press the **SQZ/HOLD** button again. The **HOLD** field will be highlighted. Press the ▲ arrow to increase hold time or press the ▼ arrow to decrease hold time.
9. To modify the settings for Pulse 2, press and hold the **Pulse 2** button to enter edit mode.
10. Repeat steps 4 through 6 to program the settings for Pulse 2.
11. Press the **SAVE** button to save any changes made. To exit "editing" mode ***without*** accepting changes, press the RUN button on the front panel which will activate the **SAVE** prompt, then press **CLEAR** to discard changes.

Set Peak Current Monitor Limits

Each of the 63 schedules has an associated set of **Monitor Limits**. To edit these limits, select the desired schedule, then:

1. Press the **LIMITS/COUNTERS** button to select this screen.
2. To edit the limits for Pulse 1, press and hold the **PULSE 1** button for about one second. The screen will turn black to indicate that the Power Supply is in edit mode. The upper limit for Pulse 1 will be highlighted. Press the ▲ arrow to increase limit or press the ▼ arrow to decrease the limit.
3. To edit the lower limit for Pulse 1, press the **PULSE 1** button again. The lower limit will be highlighted. Press the ▲ arrow to increase limit or press the ▼ arrow to decrease the limit.
4. To edit the Action for Pulse 1, press the Pulse 1 button again. Press the ▲ or ▼ arrow to select between **CONTINUE** or **INHIBIT PULSE 2**.

   NOTE: When **CONTINUE** is selected, Pulse 2 is enabled whether or not Pulse 1 is within limits. When **INHIBIT PULSE 2** is selected, Pulse 2 is inhibited when Pulse 1 is out of limits.

5. Use the **PULSE 2** button to set the upper and lower limits for Pulse 2.
6. Press the **SAVE** button to save any changes made. To exit the "editing" mode ***without*** accepting changes, press the **RUN** button on the front panel, which will activate the **SAVE** prompt, then press **CLEAR** to discard changes.

Set Weld Counter Limit or Reset the Weld Counter

The **WELD COUNTER** and **COUNTER LIMITS** apply to all weld schedules. There is not a separate counter or separate limit for each schedule. This feature is useful for counting welds made on a set of electrodes to determine when to change electrodes. This feature can also be used to count the number of welds during a particular shift or work day. After the limit is reached, the Power Supply will "beep" each time a weld is made. This signals the Operator to take action. To clear the counter or edit limit values:

1. Press the **LIMITS/COUNTERS** button to select this screen. Press and hold the **LIMITS/COUNTERS** button for about one second. The screen will turn black to indicate edit mode.
2. The **WELD COUNTER** field will be highlighted. Press the **CLEAR** button to reset this value to **000000**.

   NOTE: The ▲ or ▼ arrows do ***not*** change the Weld Counter value.
3. To change the **COUNTER LIMIT** field, press the **LIMITS/COUNTERS** button again. The **COUNTER LIMIT** field will be highlighted. Press the **CLEAR** button to set this to zero or use the ▲ or ▼ arrows to change the value.
4. Press the **SAVE** button to save changes. To exit "editing" mode ***without*** accepting changes, press RUN to activate the **SAVE PROMPT**; then press **CLEAR** on the front panel to discard changes.

Set MENU Entries

The **MENU** screen contains set-up and configuration values that apply to all schedules.

1. Press the **MENU** button to select this screen. Press and hold the **MENU** button for about one second. The screen will turn black to indicate edit mode. The **BUZZER** field will be highlighted.
2. To adjust the buzzer volume, press the ▲ or ▼ arrows to go from 1 (quiet) to 4 (loud).
3. To set the RS-232 baud rate, press the **MENU** button again. The **BAUD** rate field will be highlighted. Press the ▲ or ▼ arrows to select the desired baud rate.
4. To set the input switch debounce time, press the **MENU** button again. Press the ▲ or ▼ arrows to select either **0** or **30 MSEC** debounce time.
5. To set the starting schedule for a weld chain, press the **MENU** button again. Press the ▲ or ▼ arrows to select the starting schedule.
6. To set the ending schedule for a weld chain, press the **MENU** button again. Press the ▲ or ▼ arrows to select the ending schedule.
7. Press the **MENU** button again to select the **REMOTE** field.

8. Press the ▲ or ▼ arrows to select **ON** or **OFF**. When this is set to **OFF**, the Power Supply will not accept RS-232 commands from a remote source to change schedule or control settings. When this is set to **ON**, the unit will accept these commands. In either case the unit will accept and respond to RS-232 commands to send out weld data and information.
9. Press the **MENU** button again to select the **RESET DEFAULTS** field. Use the▲ or ▼ arrows to select ON or OFF. If this value is set to ON and is saved, then all schedules, all weld limits, Pulse 1 actions, **WELD COUNTER**, **WELD COUNTER LIMIT** and all **MENU** screen entries are set back to factory defaults.
10. Press the **SAVE** button to save any changes made. To exit the "editing" mode ***without*** accepting changes, press RUN to activate the **SAVE** prompt; then press **CLEAR** on the front panel to discard changes.

Dual Weldhead Operation

For dual weldhead operation, only schedules 1 and 2 are active. To set this feature, connect pin 13 of the 37 pin Control Signal connector to the I/O common (pin 28 or pin 32). See *Appendix B, Electrical & Data Connections* for connection details.

1. Connect weldhead 2 to the 4 pin Standard Air Valve Driver Output Connector.
2. Connect Weldhead 1 to the 8 pin Weld Head Connector.
3. Connect the Dual Weldhead Input (pin 13 on the 37 pin connector) to the I/O common (pin 28 or 32 on the 37 pin connector).
4. Schedule 1 will then use weldhead 1 and schedule 2 will use weldhead 2. These two heads and schedules will fire alternately with the Footswitch input. Do not use the RS-232 commands or the Binary Schedule Select inputs to change weld schedules when Dual Weldhead operation is active.

Programming Lock

The programmed values of the 63 schedules can be locked so that no changes are possible. To set this lock, connect pin 9 of the 37 pin Control Signal connector to the I/O common (pin 28 or pin 32). See *Appendix B, Electrical & Data Connections* for connection details.

NOTE: The schedule numbers can still be changed, but the values stored in each schedule can ***not*** be changed.

Schedule Lock

The programmed values of the 63 schedules and the schedule number itself can be locked so that no changes are possible. To set this lock, connect pin 27 of the 37 pin connector to the I/O common (pin 28 or pin 32). See *Appendix B, Electrical & Data Connections* for connection details.

Fast Welding

This feature is set in the **MENU** and determines whether data is saved automatically to non-volatile memory.

When Fast Welding is ON, data is not saved automatically to non-volatile memory. The user must push the **Save** button to save the data to non-volatile memory. If the unit is turned off before the **Save** button is pressed, the data will be lost.

When Fast Welding is OFF, the data will be saved automatically in either of two timings. If there is no weld fire signals for 12 seconds, the unit will save the data to non-volatile memory. If weld fire signals occur at intervals less than 12 seconds, the unit will stop accepting fire signals and save the data to non-volatile memory after 200 welds have been accumulated. The unit will take approximately 30 milliseconds to save the data and will ignore fire signals during this time. When the Power Supply is turned OFF, any data that has not yet been saved to non-volatile memory will be lost.

The volatile and non-volatile memory locations each 9800 welds of data. Once the locations have 9800 welds, the oldest weld will be dropped when the next weld is performed. When the unit is turned off all data in the volatile memory is lost. When the unit is turned on, all data in the non-volatile memory is copied to the volatile memory. That data will then be available to the user.

Turning the Unit OFF

Weld counters and weld data are saved periodically to the non-volatile memory in the unit. In order to maximize welding speed, this data is not saved to non-volatile memory after every single weld. In order to assure that all data is saved to non-volatile memory before turning the unit OFF, press the **SAVE** button.

Section III: Operational Notes

Repetition Rate

The 125ADP, 300 ADP, and 1000 ADP Power Supplies monitor the overall repetition rate and do ***not*** accept fire signals that occur at greater rates than listed in *Appendix A, Technical Specifications*. The 125 ADP ***does*** allow for two consecutive welds to be at a faster rate than the **Repetition Rate**. This faster rate for two consecutive welds is listed in *Appendix A* as the **Hit Rate**. The user must maintain hit rates below those specified.

Automatic Power Turn-Down

The user must limit the power dissipated in the automatic turn-down circuit to the 50W limit listed in *Appendix A, Technical Specifications*. Rapid firing of different schedules with significantly different energy level can exceed this limit. To calculate the total power dissipated in this circuit:

1. Determine how many times in one minute the schedule will change from a higher energy to a lower energy.
2. Add up the total Watt-seconds of energy decrease in one minute.
3. Divide this number by 60 to determine the average Watts of power dissipated

   Example: If there are 12 schedule changes per minute where the programmed energy decreases from 300Watt-seconds to 100Watt-seconds, the total change is 2400 Watt-seconds per minute. Dividing by 60 gives a resultant value of 40 Watts (Watt-seconds per second equals Watts), which is within the capability of the unit.

Open Load Protection

CAUTION

When the unit is fired with an open secondary circuit, the energy from the capacitor bank is ***not*** delivered to the weld. Instead, it is absorbed by the internal circuitry of the welder. If the unit were allowed to fire repeatedly into an open load with significant weld energy, it could cause internal circuits to overheat and be damaged.

In order to prevent this potential failure mode, ADP units have open load protection features. When an open load is detected by an ADP unit, the unit aborts the weld. The unit does not provide an error message if this even occurs.

The threshold for detecting an open load is typically about 10-15 milliohms. If your application requires operation with secondary circuits that exceed this resistance, please contact Miyachi Unitek for assistance.

Extended Shut-down Procedure

If the ADP unit has been turned off and non-operational for a period of 3 months or longer, an extended warm-up sequence is recommended.

1. Turn the unit ON.
2. Set the energy to the maximum level. **Example:** set the 1000ADP to 999 Watt Seconds.
3. Fire the unit once.
4. Leave the power ON and wait 15 minutes.
5. Program the desired schedule and resume normal operation.

CHAPTER 5
Maintenance

Section I. Troubleshooting

Troubleshooting

Cause of Problems: Order of Probability		
1	=	Highest Probability
2	=	High Probability
3	=	Low Probability
4	=	Lowest Probability

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Electrode Damage	1. Excessive energy setting 1. Excessive or insufficient weld head force 1. Wrong electrode tip shape 2. Contaminated weld piece surface/ plating 2. Excessively short pulse time setting 2. Wrong electrode material 2. Contaminated electrode surface	Electrode Sparking	1. Excessive energy setting 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 1. Contaminated weld piece surface/ plating 1. Wrong electrode tip shape 2. Excessively short pulse time setting 2. Wrong electrode material 2. Contaminated electrode surface
Electrode Sticking	1. Contaminated weld piece surface/ plating 1. Wrong electrode material/ tip shape 1. Insufficient weld head force 2. Excessive energy setting 2. Contaminated electrode surface 3. Slow weld head follow-up	Weld Piece Warping	1. Excessive weld time setting 1. Excessive weld head force 1. Incompatible weld piece projection design 2. Incompatible weld piece materials 2. Wrong electrode tip shape 3. Excessive current/energy setting

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Insufficient Weld Nugget	1. Insufficient energy setting 1. Wrong electrode material/ tip shape 1. Worn/mushroomed electrodes 2. Excessively long pulse time setting 2. Incorrect weld head polarity 2. Contaminated weld piece surface/ plating 2. Excessive weld head force 3. Insufficient weld head force 3. Contaminated electrode surface 3. Incompatible weld piece projection design 3. Slow weld head follow-up 4. Incompatible weld piece materials 4. No cover gas on weld piece	Metal Expulsion	1. Excessive current/energy setting 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 2. Contaminated weld piece surface/ plating 2. Incompatible weld piece materials 2. Contaminated electrode surface 2. Wrong electrode tip shape 3. No cover gas on weld piece 4. Excessively short weld time set at 125DP/300DP
Weld Piece Over-heating	1. Excessive energy setting 2. Insufficient weld head force 3. Incompatible weld piece materials 3. Wrong electrode material/tip shape 4. Contaminated electrode surface	Weld Piece Discoloration	1. No cover gas on weld piece 2. Excessive energy setting 3. Insufficient weld head force 3. Contaminated weld piece surface/ plating 4. Wrong electrode material/tip shape 4. Contaminated electrode surface

Error Messages

The power Supply displays the following error messages in the bottom line of the display. To clear these error codes, press either the **RUN** or **CLEAR** buttons. If the error has gone away, the message will then be removed. If the error is still present, the message will remain on the display.

Error Number	Error Name	Description	Troubleshooting steps
1	Capacitor Discharge timeout	The energy setting in the weld schedule was reduced, or the schedule number was changed to a schedule with a lower energy setting. The unit did not reach this new, lower energy value within 15 seconds.	1) Turn off the unit and wait 30 seconds. Turn on the unit and see if the error disappears. 2) If the error persists, contact Miyachi Unitek for service.

Error Number	Error Name	Description	Troubleshooting steps
2	Capacitor Charge timeout	The capacitors did not reach the programmed energy level within 500 msec.	1) Verify that the AC line voltage is within limits. 2) If the AC voltage is within limits and the error persists, contact Miyachi Unitek for service.
3	Firing Switch timeout	The firing switch did not close within 10 seconds of FS2 closing.	Adjust the weldhead and/or parts to be welded so that the firing switch closes within 10 seconds of FS2 closing.
4	Calibration value out of limits	The value of the capacitance entered during calibration is out of limits.	Contact Miyachi Unitek for service.
5	Memory write error.	The internal memory writing process did not complete within 1 second	Contact Miyachi Unitek for service.
6	Memory error	The values stored in memory have been corrupted. Default values have been reloaded into the unit.	Contact Miyachi Unitek for service
8	Internal communication error	An error occurred in the internal communication between the front panel and control board.	Contact Miyachi Unitek for service
10	E-stop error	The emergency stop input is open	Close the emergency stop switch
11	Chaining error	An error happened in a chaining sequence	1) Reset the chaining sequence to the first schedule in the chain 2) If the error persists, contact Miyachi Unitek for service
12	Open load detected	The resistance of the secondary circuit is too high.	1) Verify that the weldhead is closed when the unit fires. 2) Verify that the weld cables are tightly connected 3) Verify that the electrode is properly installed in the weldhead If the process requires operation with a high secondary circuit resistance, contact Miyachi Unitek for assistance

Section II. Maintenance

Calibration

Calibration must be performed by factory-trained and qualified personnel. If your Power Supply needs calibration, contact your local Miyachi Unitek service representative, or contact our service department at the address, phone number, or e-mail address listed under **Contact Us** in the front of this manual.

Electrode Maintenance

When a welding schedule has been suitable for a particular welding application over many welds, but poor quality welds are now resulting, electrode deterioration could be the problem. If you need to increase welding current to maintain the same weld heat, the electrode tip has probably increased in surface area (mushroomed), effectively decreasing weld current density, thus cooling the weld. Try replacing the electrodes.

The rough surface of a worn electrode tip tends to stick to the work pieces. So, periodic tip resurfacing (dressing) is required to remove pitting, oxides and welding debris from the electrode. You should limit cleaning of an electrode on the production line to using a #400-600 grit electrode polishing disk. If you must clean a badly damaged tip with a file, you must use a polishing disk after filing to ensure the electrode faces are smooth.

The best method of preventing electrode problems is to regularly re-grind electrode tip surfaces and shapes in a certified machine shop.

Parts Replacement

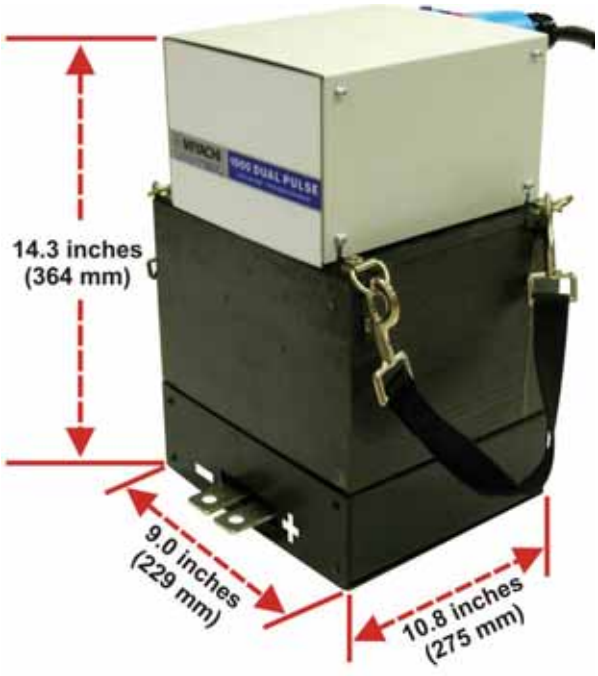
There are no user-serviceable parts inside the power Supply.

Section III. Repair Service

If you have problems with your power Supply that you cannot resolve, please contact our service department at the address, phone number, or e-mail address listed under **Contact Us** in the front of this manual.

APPENDIX A
Technical Specifications

NOTE: The specifications listed in this appendix may be changed without notice.

Item	Description
125ADP (Control Unit) **300ADP (Control Unit)** **1000ADP (Control Unit)** **Dimensions**	
Weight	125ADP 44 lbs (20kg) • 300ADP 69 lbs (31 kg) 1000ADP control unit 29 lbs (13kg)
1000ADP (Transformer) **Dimensions**	
Weight	135 lbs (61 kg)

APPENDIX A: TECHNICAL SPECIFICATIONS

Item	Description			
Input line voltage	90 - 138 VAC 50 or 60 Hz 180 - 264 VAC 50 or 60 Hz			
Overvoltage Detection	Internal switch			
Input VA (Max demand)	1300 VA			
Charge circuit type	Switched mode			
Weld Capacitor Charge Voltage	430 V max			
Weld Capacitance	As required to achieve Output Energy			
Output Energy Max per pulse	125ADP -- 125Ws 300ADP -- 300Ws 1000ADP -- 999Ws			
Voltage turndown circuit	50W average power. Automatic turndown upon power interruption			
Weld schedules	63			
Weld pulses per Schedule	2			
Repetition Rate (Pulses per minute)	**Energy**	**125ADP**	**300ADP**	**1000ADP**
	1Ws	300/min		
	2 Ws	300/min		
	3Ws	235/min	750/min	
	4 Ws	220/min		
	5 Ws	190/min		
	7 Ws	160/min		
	10Ws	140/min	520/min	170/min
	13 Ws	122/min		
	17 Ws	112/min		
	20 Ws	100/min		
	25Ws	90/min	345/min	
	35 Ws	80/min		
	40 Ws	72/min		
	50Ws	66/min	240/min	130/min
	75Ws	55/min	200/min	
	85 Ws	52/min		
	100Ws	47/min	175/min	
	125 Ws	45/min		
	150Ws		140/min	
	200Ws		120/min	
	225Ws		105/min	
	250Ws		65/min	
	300Ws		80/min	
	500 Ws			35/min
	750Ws			17/min
	1000Ws			10/min

Item	Description

Hit Rate (Pulses per minute)

Energy	125ADP	300ADP	1000ADP
1Ws	345/min		
2 Ws	310/min		
3Ws	285/min	750/min	
4 Ws	275/min		
5 Ws	265/min		
7 Ws	245/min		
10Ws	225/min	520/min	170/min
13 Ws	210/min		
17 Ws	196/min		
20 Ws	185/min		
25Ws	172/min	345/min	
35 Ws	155/min		
40 Ws	145/min		
50Ws	137/min	240/min	130/min
60 Ws	125/min		
75Ws	105/min	200/min	
85 Ws	95/min		
100Ws	75/min	175/min	
125 Ws	60/min		
150Ws		140/min	
200Ws		120/min	
225Ws		105/min	
250Ws		65/min	
300Ws		80/min	
500 Ws			35/min
750Ws			17/min
1000Ws			10/min

NOTE: The Hit Rates for the 300ADP and 1000ADP are the same as their Repetition Rates

Rise Times at Max Energy into a 1 milliohm load with very low inductance

	No Upslope			With Upslope	
	125ADP	300ADP	1000ADP	125ADP	300ADP
Very Short (**VS**)	0.65 ms	0.9 ms	0.9 ms	Not Applicable	
Short (**S**)	0.65 ms	1.0 ms	2.0 ms	0.9 ms	1.2 ms
Medium (**M**)	0.85 ms	1.5 ms	2.7 ms	1.4 ms	2.8 ms
Long (**L**)	1.2 ms	1.6 ms	3.7 ms	2.8 ms	3.3 ms

Typical Pulse duration times at Max Energy into a 1 milliohm load with very low inductance. Duration measured at 10% of peak currents.

	No Upslope			With Upslope	
	125ADP	300ADP	1000ADP	125ADP	300ADP
Very Short (**VS**)	2.0 ms	2.4 ms	2.4 ms	Not Applicable	
Short (**S**)	2.3 ms	6.0 ms	7.8 ms	2.4 ms	6.0 ms
Medium (**M**)	2.5 ms	8.0 ms	8.4 ms	2.8 ms	8.2 ms
Long (**L**)	3.9 ms	11.2 ms	11.7 ms	4.7 ms	12.2 ms

APPENDIX A: TECHNICAL SPECIFICATIONS

Item	Description
Watt Second Adjustment Range	125ADP -- 1 to 125 Watt Seconds (Ws) in 0.1 Ws increments for 1.0 ➔ 10.0 Ws, otherwise 1 Ws increments. 300ADP -- 3 to 300 Watt Seconds (Ws) in one Ws increments 1000ADP – 10 to 999 Watt Seconds (Ws) in one Ws increments
Polarity Selection	Positive, Negative, or Alternating (on 125ADP, 300ADP only)
Squeeze Time	0-2999 msec
Hold Time	0-2999 msec
Weld Counter	0-999999
Action Upon Reaching Limit	Buzzer sounds after each weld. Output relay activates.
Input Debounce Time	Approximately 32 msec
Control Outputs (See Appendix B for details)	Weld ready (24VAC or 30VDC max, 500mA max) Weld end (24VAC or 30VDC max, 500mA max) Counter reached limit (24VAC or 30VDC max, 500mA max) 24 VDC and return (for optical firing switch)
Environmental Operating Humidity Operating Temperature	 5% to 95% (Non-condensing) 5°C to 40°C (Ambient Temperature)
Valve power	24 VAC, 0.5A maximum.
	24 VDC 0.5 A maximum, including any current drawn from pins 1 and 19 of the 37 pin I/O connector.

APPENDIX B
Electrical and Data Connections

Section I. Electrical Connection

Input Power

As described in *Chapter 2, Installation & Setup,* a 115V power cord is supplied. The female end of the power cable is an IEC-320-C13 standard plug.

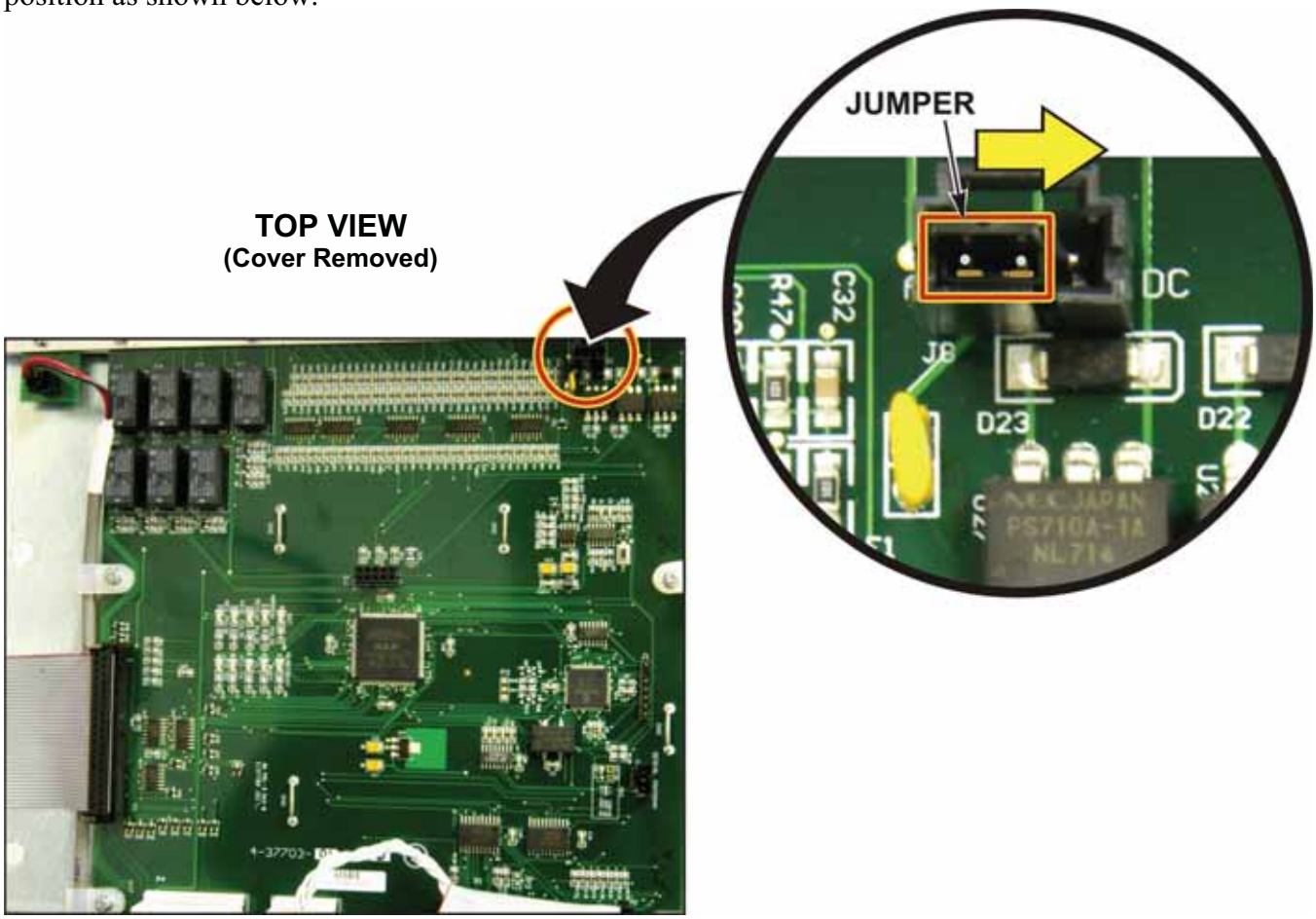
Connect the Power Supply power cable to a 1-phase, 50/60Hz power source. The nominal voltage can be either 100/120V or 200/240V.

Section II. External Input/Outputs

Converting Air Valve Driver 2 to DC output

The unit is shipped from the factory configured for 24VAC output on Air Valve Driver 2. This output can be configured to provide DC voltage. This configuration is made with one jumper.

To convert to DC output, remove the cover of the unit and locate jumper **HEAD2**. Move it to the **DC** position as shown below.

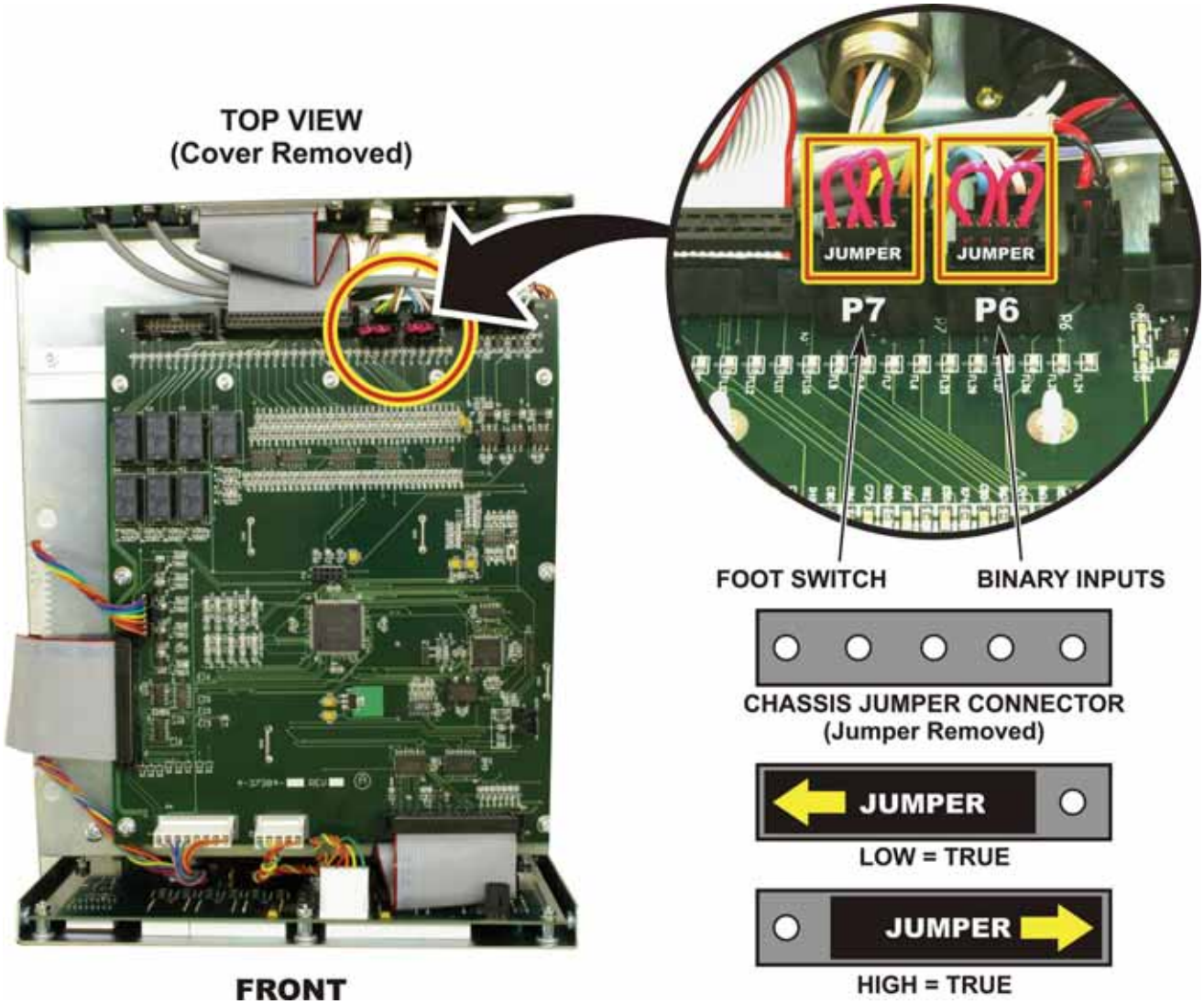


Input Logic Configuration

The unit is shipped from the factory configured for **LOW = TRUE INPUTS**. This is a common set up when using a switch closure to ground-to-activate, or to turn an input ON. The unit can also be configured for **HIGH = TRUE INPUTS**. This is a common set up for using a PLC or other external device to supply +24VDC-to-activate or to turn an input ON. This configuration is accomplished by changing two jumpers.

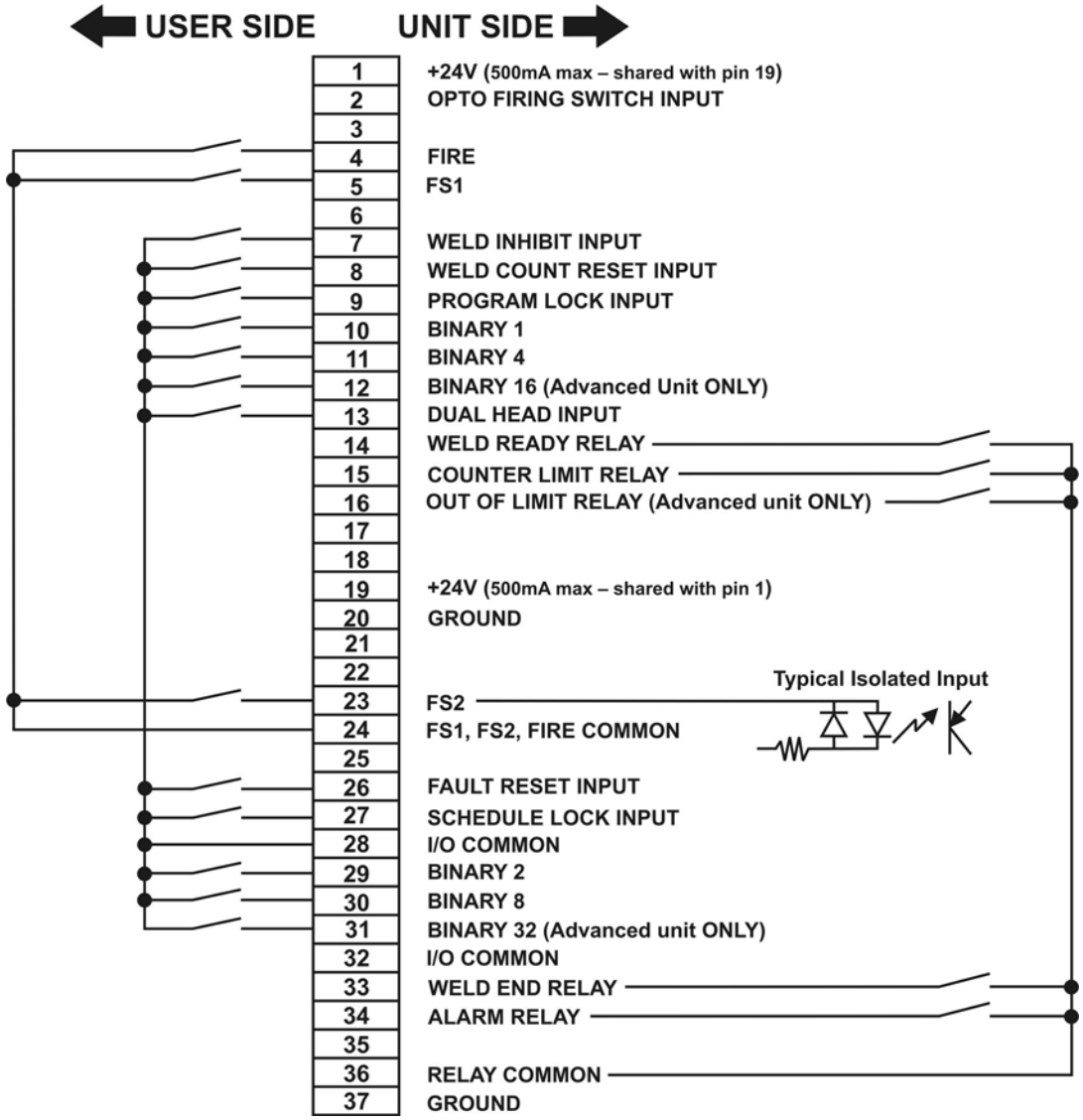
To replace the footswitch and firing switch with PLC or other **+24VDC = TRUE SIGNALS**, remove the cover of the unit and locate jumper **P6**. Move it to the **HIGH = TRUE** position as shown below. Note that this position is *only* used if Miyachi Unitek footswitch and weldhead firing switch connections are replaced by **+24VDC = TRUE INPUTS**. If a Miyachi Unitek mechanical footswitch and standard weldhead firing switch are used, this jumper should remain in the **LOW = TRUE** position.

To reconfigure all other inputs (Binary schedule select lines, weld inhibit, etc.) for **HIGH = TRUE**, move jumper **P7** to the **HIGH = TRUE** position as shown in the photograph.



Configuration for Low = True Inputs

(Switch Closure to Activate Inputs – Default Configuration)

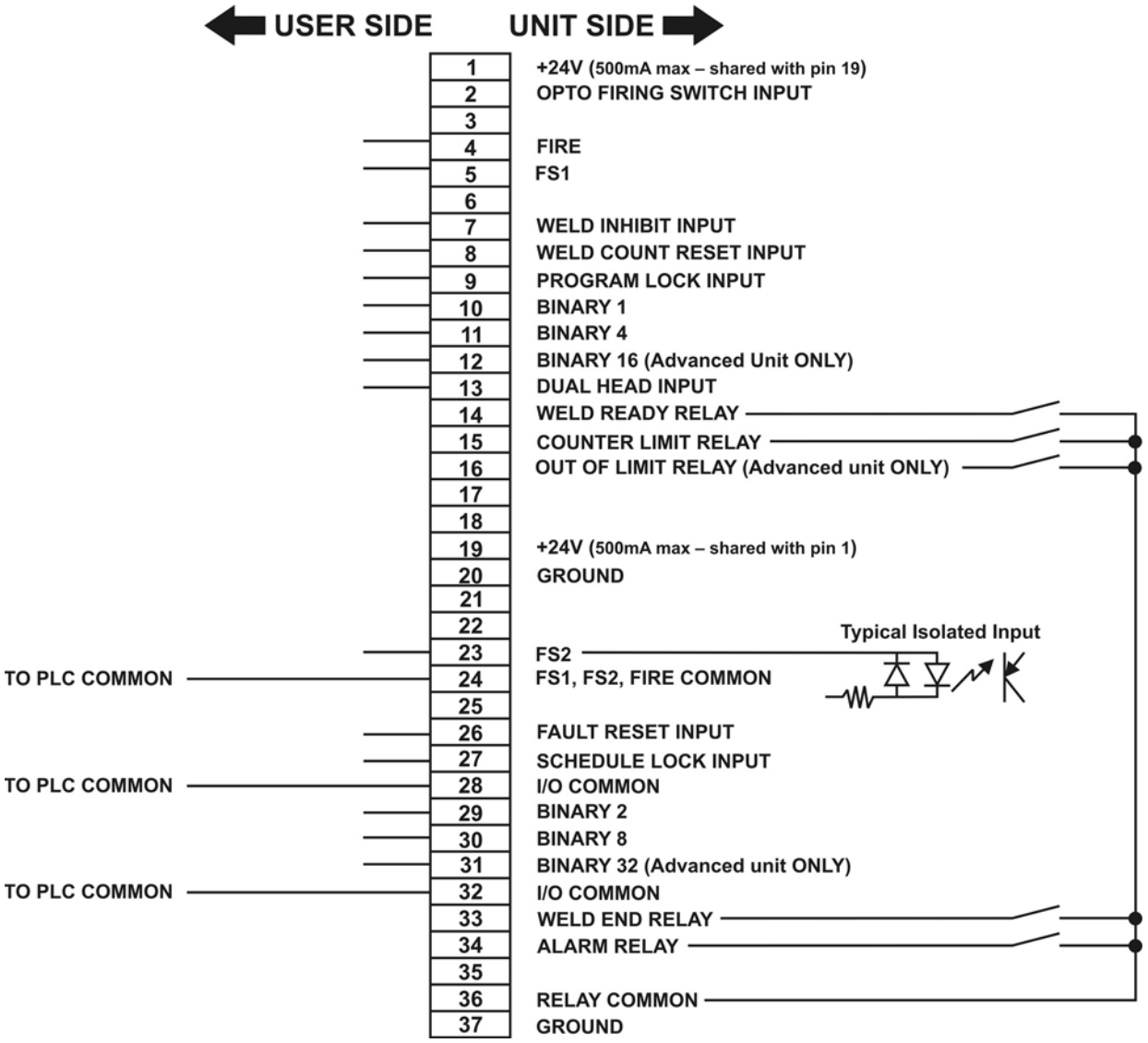


CAUTION

Damage may result from improper connection of these pins. The optical firing switch is intended for use ***only*** on Miyachi Unitek heads with this feature. In operation, an optical switch connects pin 3 to pin 20 to initiate firing. Neither of these pins should be used for any other purpose since they connect to internal, non-isolated points in the unit.

Configuration for High = True Inputs

(PLC or +24V to Activate Inputs)



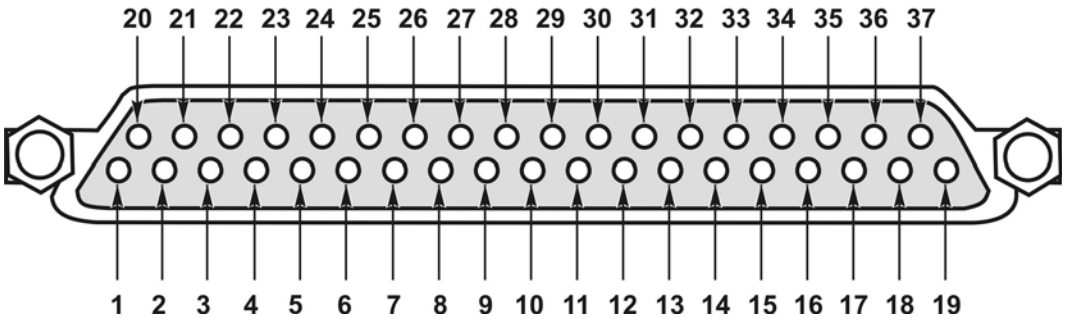
CAUTION

Damage may result from improper connection of these pins. The optical firing switch is intended for use ***only*** on Miyachi Unitek heads with this feature. In operation, an optical switch connects pin 3 to pin 20 to initiate firing. Neither of these pins should be used for any other purpose since they connect to internal, non-isolated points in the unit.

APPENDIX B: ELECTRICAL AND DATA CONNECTIONS

I/O Signal Interface General Description

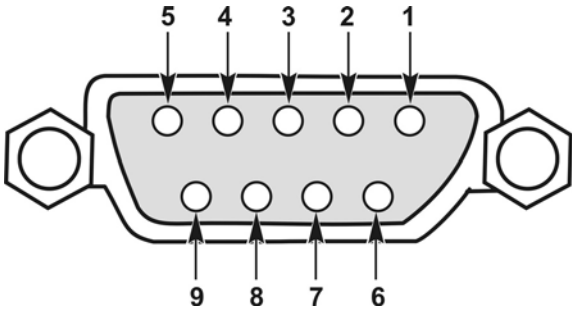
37-Pin Connector – Control Signals (As seen from the back of the power supply)



PIN	DESCRIPTION
1	+24VDC. The total current draw from pins 1 and 19 must not exceed 500 mA.
2	Optical firing switch input
3	Not used
4	Firing switch input
5	FS1 (Foot switch level 1) input
6	Not used
7	Weld inhibit input
8	Weld counter reset input
9	Program lock input
10	Binary schedule select bit 1
11	Binary schedule select bit 4
12	Binary schedule select bit 16
13	Dual weldhead input
14	Weld ready relay output
15	Counter exceeds limit relay output
16	Weld out of limits relay
17	Not used
18	Not used
19	+24VDC. The total current draw from pins 1 and 19 must not exceed 500 mA.
20	Ground
21	Not used
22	Not used
23	FS2 (Foot switch level 2)

PIN	DESCRIPTION
24	FSI, FS2, Fire Common
25	Not used
26	Fault reset input
27	Schedule lock input
28	I/O Common
29	Binary schedule select bit 2
30	Binary schedule select bit 8
31	Binary schedule select bit 32
32	I/O common
33	Weld end relay output
34	Alarm relay output
35	Not used
36	Relay common
37	Ground

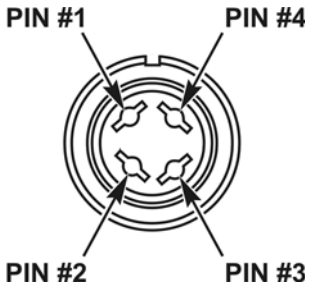
RS-232 Connections (As seen from the back of the power supply)



PIN	DESCRIPTION
1	No Connection.
2	RS-232 Transmit.
3	RS-232 Receive.
4	No Connection.
5	Signal Ground.
6	No Connection.
7	No Connection.
8	No Connection.
9	No Connection.

Two-Level Foot Switch Connector

Foot Switch Connector	
Pin	**Description**
1	Chassis Ground
2	Foot_1 (to activate Foot Switch Level 1, connect to pin 4)
3	Foot_2 (to activate Foot Switch Level 2, connect to pin 4)
4	24COM

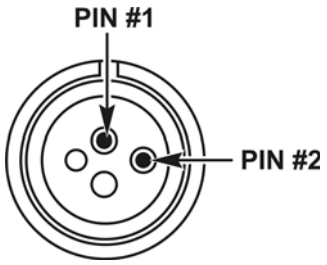


When you press the foot switch to the first level, the Power Supply energizes the air actuated weld head. This causes the upper electrode to descend and apply force to the weld pieces. If you release the foot switch before pressing it to the second level, the Power Supply will automatically return the upper electrode to its UP position so that you may re-position the weld pieces.

If you do not release the foot switch at the first level and proceed to the second level, the force-firing switch in the weld head will close. Weld current will flow, and the Power Supply will automatically return the upper electrode to its UP position.

Standard Air Valve Driver Output Connector

Air Valve Driver 24 VAC Connector	
Pin	**Description**
1	24VAC (for solenoid) or 24VDC
2	HEAD_2 (Switched 24VDC common)



The air valve driver output (24VAC) is initiated when Foot Switch Level 1 is initiated. If a PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3. The mating connector is an AMP type 206429-1, using cable clamp AMP type 206358-2. The two male pins used are Amp type 66361-2.

Force Firing Switch Cable Input

Function

The force-firing switch input to the Control from the weld head signals that the selected pressure has been applied to the weld pieces. Note that a mechanical firing switch is subject to contact bounce, which can cause false weld starts. The effects of switch bounce can be avoided at low weld speeds by using the switch debounce function on the Control main menu. If welding speeds are to exceed 1.5 welds per second, use an optical firing switch.

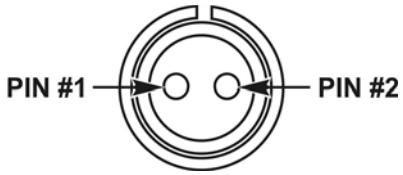
Connections

The firing switch cable is 5 feet long, Type 2/C, 600-volt cable containing two shielded, twisted pair 22 AWG stranded leads.

The firing switch cable connector is a 2-pin Amphenol Type 80-MC2FI. It mates with the weld head firing switch connector, which is a 2-Pin Amphenol Type 80-MC2M.

Firing Switch Connector

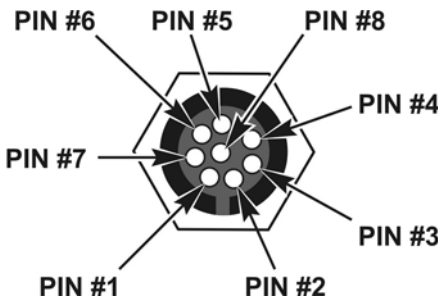
Pin	Description
1	24COM
2	FIRE_1



Weld Head Connector

Weld Head Connector

Pin	Description
1	HEAD_1 (switched 24V common for solenoid)
2	24V_OUT (24VDC for solenoid)
3	24COM
4	FIRE_1
5	VOLT_IN (not used)
6	VOLT_COM (not used)
7	AIRHEAD (not used)
8	Not used



The Weld Head Connector combines all the inputs and outputs necessary to connect a plug-and-play *EZ-AIR* Miyachi Unitek weld head. If PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3.

Operator Emergency Stop Cable Switch Input

Function

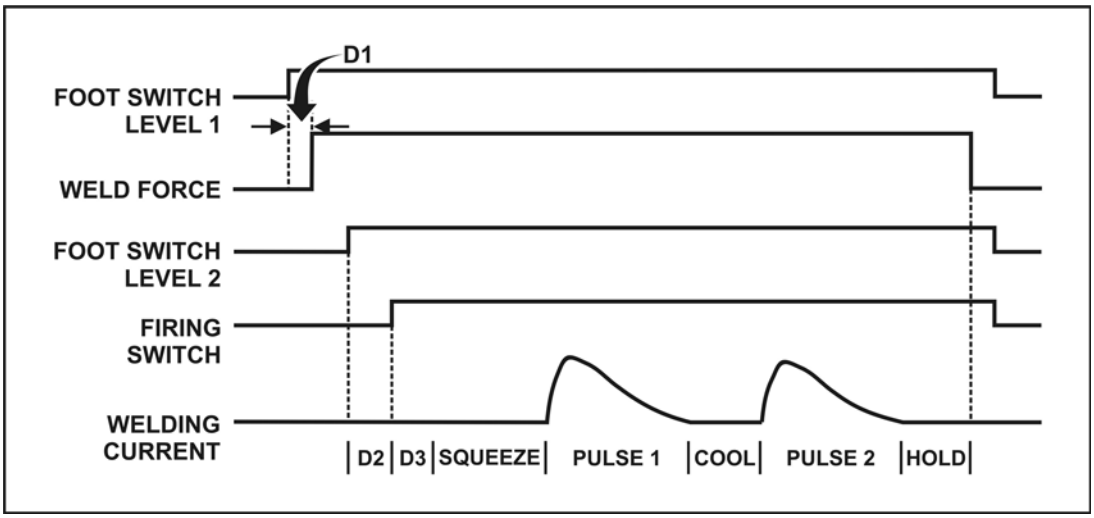
Connect an agency recognized, normally closed **Emergency Stop Switch** to the cable provided on the rear panel. Use the switch during Power Supply operation as an **Emergency Stop Switch.** When operated (opened), it will immediately halt the weld process and de-energize all ADP outputs

Connections

You ***must*** connect the **Emergency Stop Switch Cable** leads, otherwise the Power Supply will not function. Connect an agency recognized, normally closed **Emergency Stop Switch** between conductors of the 2-foot (61 cm) operator **Emergency Stop Switch** cable. When the switch is operated (opened), it de-energizes all power outputs from the Power Supply. If you choose not use an **Emergency Stop Switch,** an electrical short is required between cable leads for the Power Supply to be functional.

APPENDIX C
System Timing

Basic Weld Operation: Air Head System with Two-Level Foot Switch



Definitions

D1 Delay time from Foot Switch Level 1 closure to Weld Force start. This time ranges from 10 to 40 msec depending upon the debounce setting.

D2 Delay time from Weld Force start to Firing Switch closure. Maximum D2 time is 10 seconds. If the firing switch does not close within approximately 10 seconds, the message **FIRING SWITCH DIDN'T CLOSE IN 10 SECONDS** will display.

D3 Delay time from Firing Switch closure and Foot Switch Level 2 closure to squeeze time (**SQZ**). Maximum D3 time is 60 ms.

SQZ Squeeze time. Selectable range is 0 to 2999 ms. Typical accuracy is -0%/+10%

Pulse 1 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

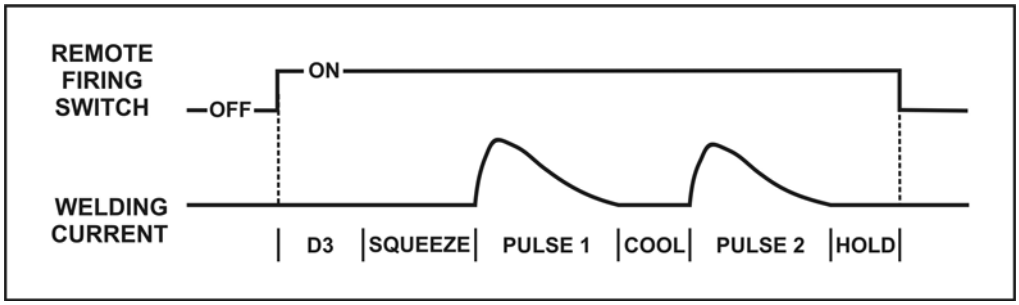
COOL This time is not programmable by the user. It depends upon the energy level of the second pulse, and ranges from 20 to 670 msec on the 125ADP and 300 ADP. It can range up to 1.5 seconds on the 1000ADP. If no second pulse is programmed, this time period is skipped. Changing pulse widths or polarities may result in longer cool times than if no changes are made to these parameters.

Pulse 2 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

HOLD Hold time. Selectable range is 0 to 2999 ms. Typical accuracy is -0%/+10%

NOTE: The inputs signals (FS1, FS2 and firing switch) need to be ***at least 50 msec duration*** for the unit to recognize them.

Basic Weld Operation: Manual Head System with Firing Switch Operation



Definitions

D3 Delay time from firing switch closure to the start of the weld sequence (that is, start of **SQZ**). . This time ranges from 10 to 40 msec depending upon the debounce setting.

SQZ Squeeze time. Selectable range is 0 to 2999 ms. Typical accuracy is -0%/+10%

Pulse 1 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

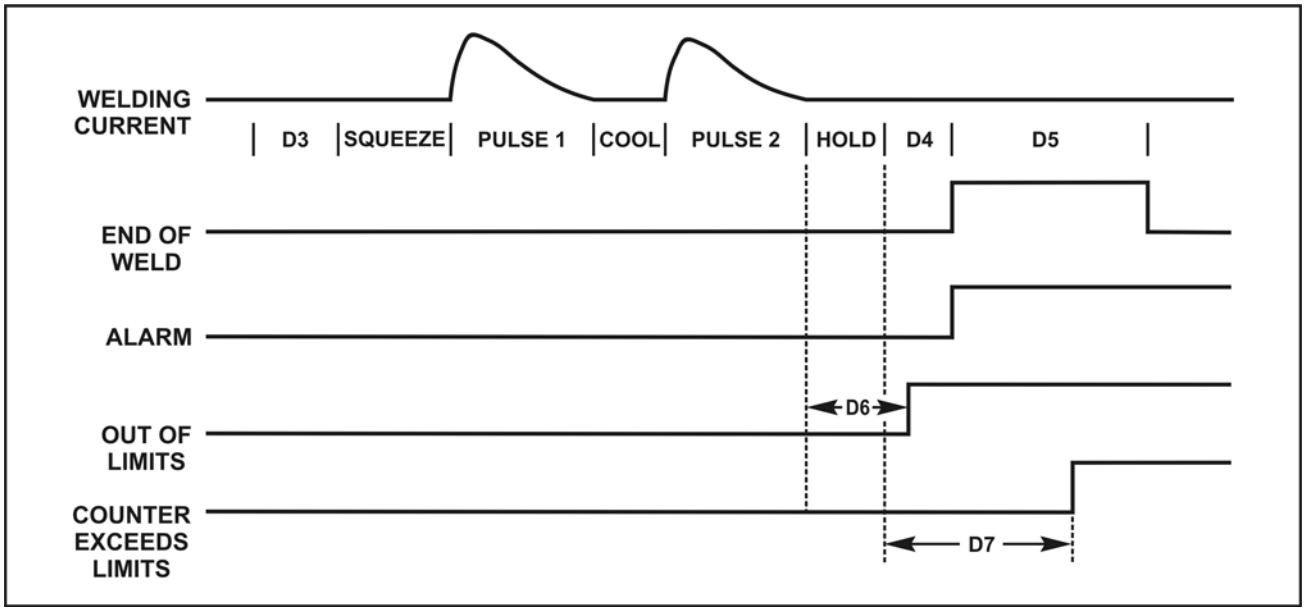
COOL This time is not programmable by the user. It depends upon the energy level of the second pulse, and ranges from 20 to 670 msec on the 125ADP and 300 ADP. It can range up to 1.5 seconds on the 1000ADP. If no second pulse is programmed, this time period is skipped. Changing pulse widths or polarities may result in longer cool times than if no changes are made to these parameters.

Pulse 2 The timing of this weld pulse depends upon the pulse length programmed, the energy setting and the impedance of the secondary circuit

HOLD Hold time. Selectable range is 0 to 2999 ms. Typical accuracy is -0%/+10%

NOTE: The firing switch signal needs to be ***at least 50 msec duration*** for the unit to recognize it.

Relay Timing



Definitions

D4 Delay time from the end of **HOLD** time until the **END OF WELD** or **ALARM** relay turns on. This time is 25 ms or less in most cases. However, if the energy remaining in the capacitor bank at the end of pulse 2 is greater than the energy required for Pulse 1 of the next weld, the unit will discharge the capacitor bank to the proper energy level. The end of weld relay will be delayed until the proper energy level is reached.

D5 Duration of the **END OF WELD** relay. This is from 100 to 125 ms.

D6 Delay time from the end of the weld pulse until the **OUT OF LIMITS** relay turns on. This time ranges from 100 to 250 msec.

D7 Delay time from the end of **HOLD** time until the **COUNTER EXCEEDS LIMIT** relay turns On. This is from 125 to 250 msec.

APPENDIX D
Communications

Section I. Introduction

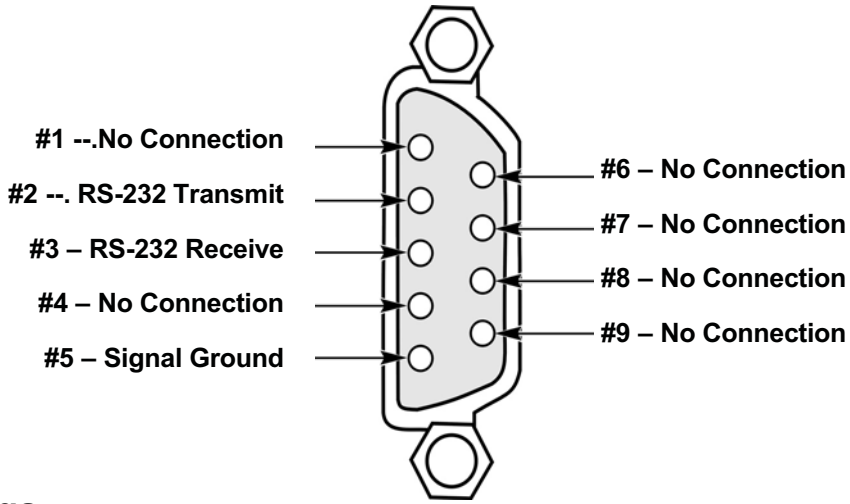
Overview

The Power Supply has the ability to communicate with a host computer or with automation control system. The communications option uses RS-232 to connect one control to one host.

Remote Programming

The codes needed to perform remote programming are listed in *Section II, Communications Protocol and Commands*. Using these codes, users can write customized software for controlling all functions of the welding control and interfacing the unit to automation control systems.

RS-232 Serial Connector Information



RS-232 settings

Baud Rate	9600, 19.2k, and 38.4k Baud
Data bits	8
Stop bit	1
Parity	None

NOTES:

- The host must be set to the same baud rate as the unit.
- For a microprocessor-based conversion (such as the Edgeport USB converter from Inside Outside Networks), the host computer should be at least a Pentium II-233 running Windows 98, Windows ME, Windows 2000, Windows XP or Windows NT 4.0.

Section II. Communications Protocol and Commands

Command Format

Each external command will be formatted as follows:

<stx> <cmd> <cnt> <data> <cksum> <etx>.

Definition of a Command:

<stx>	1 BYTE	The data packet will start with a STX (start of text 0x02) character.
<cmd>	2 BYTES	This is a two character ASCII string denoting the command. (i.e. “TY”).
<cnt>	2 BYTES	This is a count of data bytes to follow, converted into a decimal ASCII number. (“00” to “99”).
<data>	n BYTES	This is ASCII numbers or ASCII data and may or may not be required by the command. See the individual command. Multiple byte ordering is: [MSB][…][LSB]
<cksum>	2 BYTES	This is a two charter ASCII HEX string calculated from the sum of all bytes except <stx>, <cksum>, and <etx>. Then masked with 255 (0xFF).
<etx>	1 BYTE	This terminates the transmission. (End of text 0x03).

The ADP will respond with a Negative Acknowledge Command (”**NK”)** when an error is encountered in response to a command. The format and reasons follow.

<stx> **”NK”** <cnt> <err> <cksum> <etx>.

Where <err> = '1' NO <SOH>.

‘2’ BAD checksum.

‘3’ Unrecognized command.

‘4’ Timeout.

‘5' In Local.

‘6’ Data Bad.

A valid command will return EITHER DATA OR **”AK”**.
The **<ACK>** format is: **<stx> “AK” <cnt> <data> <cksum> <etx>.**

The **DATA** format is: **<stx> <cmd> <cnt> <ascii data> <cksum> <etx>.**

When you issue a command to the ADP, you need to wait for the response before you issue the next command. This waiting period should be at least 250 msec. The ADP should respond within this timeout.

VARIABLE: *italics.*

RANGE OF PARAMETERS: *low_end - high_end* (separated by hyphen).

Host Originated Command Set

These are commands sent by the host computer, via the RS-232 port to the ADP.

NAME	COMMAND	DATA	SIZE
TYPE	”TY” Read	None. Returns Type of Welder	0 Bytes
STATUS	”TS” Read	None. Returns status of last weld.	0 Bytes
REAR	“TR” Read	None. Returns the rear panel status.	0 Bytes
RESET	“RX” Set	None. Reset an Error	0 Bytes
WELD	“TC” Read	None. Returns the current weld counter.	0 Bytes
COUNTER	“TG” Read	None. Returns Good and Bad Weld counts.	0 Bytes
LIMITS	“TL” Read	None. Returns Weld count Limit.	0 Bytes
COUNT	“RC” Read	None. Returns # of stored welds	0 Bytes
REPORT	”RR” Read	Request # (1-6 or Retransmission = ‘F’) READ ORDER, (N=new, O=Old),	1 Byte 1 Byte 2 Bytes Total
REMOTE	”RM” Set	0=Local, 1=Remote	1 Byte
WELD ZERO	“CR” Set	Reset Weld Counter (zero = 1)	1 Byte
WELD LIMIT	“CS” Set	Weld Limit Value.	6 Bytes
LOAD	”LR” Read ”LS” Set	None, Returns current schedule number 01-63 = Sets active schedule	0 Bytes 2 Bytes

SCHEDULE	"SR"	Read	Schedule #. Reads current schedule data		2 Bytes
SCHEDULE	"SS"	Set	SCHEDULE #,		2 Bytes
			SQZ #,	(Squeeze Time),	4 Bytes
			WS #1,	(Energy in Watt Seconds),	3 Bytes
			WS #2,	(Energy in Watt Seconds),	3 Bytes
			HOLD #,	(Hold Time),	4 Bytes
			PULSE1,	(***weld length***),	1 Byte
			PULSE2,	(***weld length***),	1 Byte
			POLARITY1,	(***weld polarity***),	1 Byte
			POLARITY2,	(***weld polarity***),	1 Byte
			UP #,	(Up Slope, 0=Off, 1=On),	1 Byte
					21 Bytes Total

---

weld length 0=Very short, 1=Short, 2=Medium, 3=Long.
weld polarity 0=Positive, 1=Negative, 2=Alternating.

Note: The "SS" Set commands for PULSE1, PULSE2, POLARITY1, and POLARITY2 do not apply to the 1000ADP

LIMITS	"MR"	Read	Schedule #		2 Bytes
LIMITS	"MS"	Set	SCHEDULE #,		2 Bytes
			P1 Upper Limit,		4 Bytes
			P1 Lower Limit,		4 Bytes
			P1 Action	(***action***)	1 Byte
			P2 Upper Limit		4 Bytes
			P2 Lower Limit		4 Bytes
					19 Bytes Total

---

action 0 = NONE, 1 = INHIBIT P2

SYSTEM	"YR"	Read	none		0 Bytes
SYSTEM	"YS"	Set	BAUD RATE	***(rate)***	1 Byte
			DEBOUNCE	(0=None, 1=30ms)	1 Byte
			BUZZER	(0=Off, 1, 2, 3=loud)	1 Byte
			FAST WELDING	(0=Off, 1= On)	1 Byte
			REMOTE	(0=Off, 1= On)	1 Byte
			CHAINING START,	(0=Off, 01-63)	2 Bytes
			CHAINING END	(0=Off, 01-63)	2 Bytes
					9 Bytes Total

---

rate 0=9600, 1=19.2 k, 2=38.4 k Baud

ADP Originated Command Set

These are commands returned by the ADP 125, ADP 300, and ADP 1000 to the host computer via the RS-232 port.

NAME	COMMAND		DATA	SIZE
TYPE	”TY”	Read	“ADP”, Release # and Revision #. Example: “ADP 300 1.02 C”.	14 Bytes
RESET	“RX”	Set	Reset an Error, Returns STATUS “TS”	1 Byte
WELD	“TC”	Read	The current weld counter.	6 Bytes
COUNTER	“TG”	Read	Good (6 bytes) and Bad (6 bytes) counters.	12 Bytes
LIMITS	“TL”	Read	Weld count Limit.	6 Bytes
COUNT	“RC”	Read	Returns # of stored welds.	4 Bytes
REMOTE	”RM”	Set	<ACK **OR** NAK>	1 Byte
WELD ZERO	“CR”	Set	<ACK **OR** NAK>	1 Byte
WELD LIMIT	“CS”	Set	<ACK **OR** NAK>	1 Byte
LOAD	”LS”	Set	<ACK **OR** NAK>	1 Byte
	”LR”	Read	The active schedule #.	2 Bytes
REPORT	”RR”	Read	Schedule #, {1 to 63}	2 Bytes
			Weld Status, {0=Good, 1=Out of Limits}	1 Byte
			1st pulse Current,	3 Bytes
			2nd pulse Current,	3 Bytes
			Weld Number.	6 Bytes
				15 Bytes Total
REAR	“TR”	Read	Returns the rear panel status in HEX.	1 Byte
			Dual Weld Head (0^{th})	1 Bit
			Weld Inhibit (1^{st})	1 Bit
			Schedule Lock (2^{nd})	1 Bit
			Program Lock (3^{rd})	1 Bit
			Emergency Stop (4^{th})	1 Bit
			FS2 (5^{th})	1 Bit
			FS1 (6^{th})	1 Bit
			Fire Switch (7^{th})	1 Bit

STATUS	"TS"	Read	Status of unit or the last weld. 0 = GOOD. 1 = Capacitors did not discharge in 15 seconds. 2 = Capacitor does not charge in time. 3 = Firing switch does not close within 10 seconds of FS2 closing. 4 = The capacitor calibration value is outside of limits. 5 = Internal EEPROM memory error. 6 = Internal EEPROM values corrupted. Default values loaded. 7 = Power board fuse blown. 8 = Communication error between control board and front panel. 9 = Exiting Edit mode. 10 = Emergency Stop (EMO) input is open. 11 = Invalid Chaining start or end value. 12 = Last Weld was out of Limits.		2 Bytes
SYSTEM	"YS"	Set	<ACK **OR** NAK>		1 Byte
SYSTEM	"YR"	Read	BAUD RATE	***(rate)***	1 Byte
			DEBOUNCE	(0=None, 1=30ms)	1 Byte
			BUZZER	(0=Off, 1, 2, 3, 4=loud)	1 Byte
			FAST WELDING	(0=Off, 1= On)	1 Byte
			REMOTE	(0=Off, 1= On)	1 Byte
			CHAINING START,	(0=Off, 01-63)	2 Bytes
			CHAINING END	(0=Off, 01-63)	2 Bytes
					9 Bytes Total

---

rate 0=9600, 1=19.2 k, 2=38.4 k Baud

SCHEDULE	"SS"	Set	<ACK **OR** NAK>		1 Byte
SCHEDULE	"SR"	Read	SCHEDULE #,		2 Bytes
			SQZ #,	(Squeeze Time),	4 Bytes
			WS #1,	(Energy in Watt Seconds),	3 Bytes
			WS #2,	(Energy in Watt Seconds),	3 Bytes
			HOLD #,	(Hold Time),	4 Bytes
			PULSE1,	(***weld length***),	1 Byte
			PULSE2,	(***weld length***),	1 Byte
			POLARITY1,	(***weld polarity***),	1 Byte
			POLARITY2,	(***weld polarity***),	1 Byte
			UP #,	(Up Slope, 0=Off, 1=On),	1 Byte
					21 Bytes Total

---

weld length 0=Very short, 1=Short, 2=Medium, 3=Long.
weld polarity 0=Positive, 1=Negative, 2=Alternating.

MONITOR	"MS"	Set	<ACK **OR** NAK>		1 Byte
MONITOR	"MR"	Read	SCHEDULE #,		2 Bytes
			P1 Upper Limit,		4 Bytes
			P1 Lower Limit,		4 Bytes
			P1 Action	(***action***)	1 Byte
			P2 Upper Limit		4 Bytes
			P2 Lower Limit		4 Bytes
					19 Bytes Total

---

action 0 = NONE, 1 = INHIBIT P2

EXAMPLE #1

An example of sending a TYPE command to the ADP: <STX>"TY000D"<ETX>
The command: "TY"
The Count is: "00"
The check sum is "0D". Which is calculated from the ASCII (American Standard code for information interchange) and is a two charter ASCII HEX string calculated from the sum of all bytes except <stx>, <cksum>, and <etx>. 'T' + 'Y' + '0' + '0'
Looking up the value for each character, We get 0x54 + 0x59 + 0x30 + 0x30 = 0x10D HEX
In decimal 84 + 89 + 48 + 48 = 269 decimal.
The check sum is a value between 0 and 255; Therefore, 269 – 255*n = 14 decimal = 0D hex.
Where n = (check sum / 255). Here it is only 1.
If the check sum was 9C4 hex = 2500 decimal. Then n = 2500 / 256 = 9.7.
Using only the hole number n = 9
The final check sum is (2500 – (256 * 9)) = 196 decimal or 0xC4 hex
A better way is to take the final check sum and AND it with 255 (0x0FF).
In hex, taking the final check sum 0x9C4 and ANDing it with 0xFF = 0xC4, or in decimal 2500 AND 255 = 196.

EXAMPLE #2

Now we wish to find out how many welds are stored in the ADP weld buffer.
The total command is: <STX>"TC00F7"<ETX>. "TC" is the command, "00" is the count, and "F7" is the check sum.

If the ADP send back: <STX>"TC0600000522"<ETX>, then the command is "TC" (or current weld counter), the data count is 6 ("06"), and the number of welds stored is 5 ("000005"). The check sum is 22 hex (in decimal 84 + 67 + 48 + 54 + 48 + 48 + 48 + 48 + 48 + 53 = 546.
546 / 256 = 2.13. Therefore the check sum is 546 – (256*2) = 34 decimal or 22 hex.

ADP Commands Alphabetically:

CR	Reset Weld Counter
CS	Set Weld Limit
LR	Read current schedule
LS	Set active schedule
MR	Monitor Limits (Read)
MS	Monitor Limits (Set)
RC	Number of reports stored
RM	Set Remote
RR	Read Report
RX	Reset an Error
SR	Schedule (Read)
SS	Schedule (Set)
TC	Read Weld Counter
TG	Read Good & Bad Counters
TL	Read Weld Count Limit
TR	Rear Panel Status
TS	Read Status of last weld
TY	Read the Type
YR	System (Read
YS	System (Set)

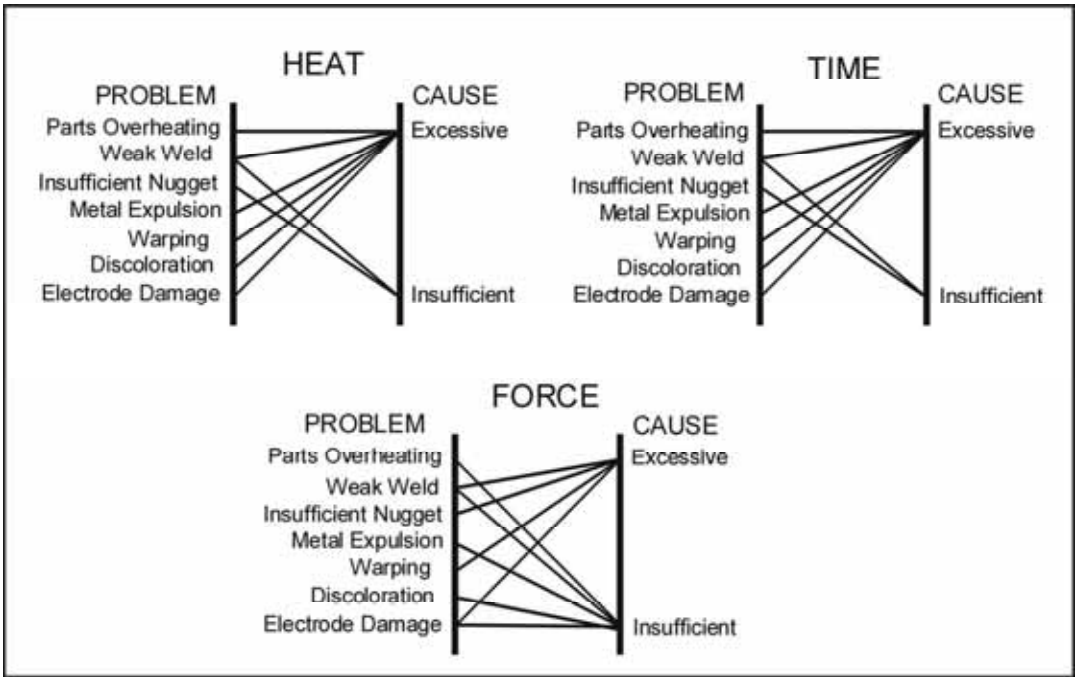
APPENDIX E
The Basics Of Resistance Welding

Resistance Welding Parameters

Resistance welding heat is produced by passing electrical current through the parts for a fixed time period. The welding heat generated is a function of the magnitude of the weld current, the electrical resistance of the parts, the contact resistance between the parts, and the weld force applied to the parts. Sufficient weld force is required to contain the molten material produced during the weld. However, as the force is increased, the contact resistance decreases. Lower contact resistance requires additional weld current, voltage, or power to produce the heat required to form a weld.

The higher the weld force, the greater the weld **current**, **voltage**, **power**, or **time** required to produce a given weld. The formula for amount of heat generated is $\mathbf{I^2RT}$ -- the square of the weld current [**I**] times the workpiece resistance [**R**] times the weld time [**T**].

Welding Parameter Interaction



Interaction of Welding Parameters

Electrode Selection

Correct electrode selection strongly influences how weld heat is generated in the weld area. In general, use conductive electrodes such as a RWMA-2 (Copper alloy) when welding electrically resistive parts such as nickel or steel so that the weld heat is generated by the electrical resistance of the parts and the contact resistance between the parts. Use resistive electrodes such as RWMA-13 (Tungsten) and RWMA-14 (Molybdenum) to weld conductive parts such as copper and gold because conductive parts do not generate much internal heat so the electrodes must provide external heat. Use the following Electrode Selection Table for selecting the proper electrode materials.

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Alumel	-2	Alumel	-2
Alumel	-2	Chromel	-2
Alumel	-2	Dumet	-2
Aluminum	-1	Aluminum	-1
Aluminum	-1	Aluminum Alloys	-1
Aluminum	-1	Cadmium Plating	-1
Aluminum	-1	Tinned Brass	-14
Aluminum	-1	Tinned Copper	-14
Aluminum	-1	Gold Plated Dumet	-2
Aluminum	-1	Gold Plated Kovar	-2
Aluminum	-1	Kovar	-2
Aluminum	-1	Magnesium	-1
Aluminum	-1	Cold Rolled Steel	-2
Aluminum	-1	Stainless Steel	-2
Beryllium Copper	-2	Beryllium Copper	-2
Beryllium Copper	-2	Brass	-2, -14
Beryllium Copper	-2	Copper	-14
Beryllium Copper	-2	Tinned Copper	-14
Beryllium Copper	-2	Nickel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Beryllium Copper	-2	Cold Rolled Steel	-2
Beryllium Copper	-2	Stainless Steel	-2
Brass	-2, -14	Brass	-2, -14
Brass	-2, -14	Tinned Brass	-14
Brass	-2, -14	Consil	-2
Brass	-2, -14	Constantan	-2
Brass	-2, -14	Copper	-14
Brass	-2, -14	Tinned Copper	-14
Brass	-2, -14	Dumet	-2
Brass	-2, -14	Nichrome	-2
Brass	-2, -14	Nickel	-2
Brass	-2, -14	NiSpan C	-2
Brass	-2, -14	Paliney 7	-2
Brass	-2, -14	Silver	-11, -14
Brass	-2, -14	Cold Rolled Steel	-2
Brass	-2, -14	Stainless Steel	-2
Bronze	-2, -11	Bronze	-2, -11
Bronze	-2, -11	Tinned Copper	-14
Bronze	-2, -11	Iron	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Bronze	-2, -11	Nichrome	-2
Bronze	-2, -11	Nickel	-2
Chromel	-2	Chromel	-2
Chromel	-2	Constantan	-2
Chromel	-2	Copel	-2
Chromel	-2	Copper	-14
Chromel	-2	Tinned Copper	-14
Chromel	-2	Dumet	-2
Chromel	-2	Nichrome	-2
Chromel	-2	Cold Rolled Steel	-2
Consil	-2	Consil	-2
Consil	-2	Tinned Copper	-14
Consil	-2	Dumet	-2
Constantan	-2	Constantan	
Constantan	-2	Copper	-14
Constantan	-2	Tinned Copper	-14
Constantan	-2	Iron	-2
Constantan	-2	Nichrome	-2
Constantan	-2	Nickel	-2
Copper	-14	Copper	-14
Copper	-14	Dumet	-2
Copper	-14	Invar	-2
Copper	-14	Karme	-2
Copper	-14	Manganin	-2
Copper	-14	Nichrome	-2
Copper	-14	Nickel	-2
Copper	-14	Paliney 7	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Copper	-14	Silver	-11, -14
Copper	-14	Cold Rolled Steel	-2
Copper	-14	Stainless Steel	-2
Dumet	-2	Dumet	-2
Dumet	-2	Nichrome	-2
Dumet	-2	Nickel	-2
Dumet	-2	Platinum	-2
Dumet	-2	Cold Rolled Steel	-2
Evanohm	-14	Copper	-14
Gold	-14	Gold	-14
Gold	-14	Kovar	-2
Hastalloy	-2	Titanium	-2
Inconel	-2	Inconel	-2
Inconel	-2	Kulgrid	-2
Invar	-2	Invar	-2
Iridium	-2	Iridium	-2
Iridium	-2	Platinum	-2
Iron	-2	Iron	-2
Karma	-2	Karma	-2
Karma	-2	Nickel	-2
Karma	-2	Platinum	-2
Kovar, Gold Plate	-2	Kovar, Gold Plate	-2
Kovar, Gold Plate	-2	Kulgrid	-2
Kovar, Gold Plate	-2	Nickel	-2
Kovar, Gold Plate	-2	Silver	-11, -14
Kovar, Gold Plate	-2	Stainless Steel	-2
Magnesium	-1	Magnesium	-1

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Molybdenum	-2	Nickel	-2
Molybdenum	-2	Tungsten	-2
Nichrome	-2	Nichrome	-2
Nichrome	-2	Nickel	-2
Nichrome	-2	Cold Rolled Steel	-2
Nichrome	-2	Stainless Steel	-2
Nickel	-2	Nickel	-2
Nickel	-2	Cold Rolled Steel	-2
Nickel	-2	Stainless Steel	-2
Nickel	-2	Tantalum	-2
Nickel	-2	Tungsten	-2
Nickel Alloy	-2	Nickel Alloy	-2
Nickel Alloy	-2	Tinned Brass	-14
Nickel Alloy	-2	Beryllium Copper	-2
Nickel Alloy	-2	Consil	-2
Nickel Alloy	-2	Tinned Copper	-14
Nickel Alloy	-2	Nichrome	-2
Nickel Alloy	-2	Nickel	-2
Nickel Alloy	-2	Cold Rolled Steel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
NiSpan C	-2	NiSpan C	-2
NiSpan C	-2	Cold Rolled Steel	-2
NiSpan C	-2	Stainless Steel	-2
Niobium	-2	Niobium	-2
Platinum	-2	Platinum	-2
Paliney 7	-2	Paliney 7	-2
Silver	-11, -14	Silver	-11, -14
Silver	-11, -14	Cadmium	-13
Cold Rolled Steel	-2	Cold Rolled Steel	-2
Cold Rolled Steel	-2	Stainless Steel	-2
Cold Rolled Steel	-2	Tantalum	-2
Stainless Steel	-2	Stainless Steel	-2
Stainless Steel	-2	Tungsten	-2
Tantalum	-2	Tantalum	-2
Titanium	-2	Titanium	-2
Tungsten	-2	Tungsten	-2
Tungsten	-2	henium	-2
Zinc	-14	Zinc	-14

Electrode Maintenance

Depending on use, periodic tip resurfacing is required to remove oxides and welding debris from electrodes. Cleaning of electrodes on production line should be limited to use of #400-600 grit electrode polishing disks. For less critical applications, a file can be used to clean a badly damaged tip. However, after filing, polishing disks should then be used to ensure that the electrode faces are smooth. If this is not done, the rough surface of the electrode face will have a tendency to stick to the work piece.

Weld Schedule Development

Developing a weld schedule is a methodical procedure, which consists of making sample welds and evaluating the results. The first weld should be made at low energy settings. Adjustments are then made to each of the welding parameters ***one at a time*** until a successful weld is made.

1 Install the correct electrodes in the electrode holders on the Weld Head. See the preceding Table for electrode material recommendations.

2 Use a flat electrode face for most applications. Use a "domed" face if surface oxides are a problem. If either of the parts is a wire, the diameter of the electrode face should be equal to or greater than the diameter of the wire. If both parts are flat, the face should be at least one-half the diameter of the electrodes. Pencil point electrodes cause severe electrode sticking to the parts, unexplained explosions, and increase the weld heat substantially because of the reduced electrode-to-part contact area.

3 Use the Force Adjustment Knob on the Weld Head to set the Firing Force and adjust an Air Actuated Weld Head.

4 Program a weld schedule, then make your first weld. Always observe safety precautions when welding and wear safety glasses. For a complete procedure on making welds, refer to *Operating Instructions*.

5 Use pliers to peel the welded materials apart. A satisfactory weld will show residual material pulled from one material to the other. Tearing of base material around the weld nugget indicates a material failure NOT a weld failure. Excessive electrode sticking and/or "spitting" should define a weld as unsatisfactory and indicates that too much weld current, voltage, power, or time has been used.

6 If the parts pull apart easily or there is little or no residual material pulled, the weld is weak. Increase the weld time in 1 msec increments. Increase weld current, voltage, or power if a satisfactory weld achieved using 10 msec of weld time.

NOTE: Actual weld strength is a user-defined specification.

7 Polarity, as determined by the direction of weld current flow, can have a marked effect on the weld characteristics of some material combinations. This effect occurs when welding materials with large differences in resistivity, such as copper and nickel or when welding identical materials with thickness ratios greater than 4 to 1. The general rule is that the more resistive material or the thinner material should be placed against the negative (-) electrode. Polarity on the Control can only be changed by reversing the Weld Cables.

Weld Strength Testing

Destructive tests should be performed on a random basis using actual manufacturing parts. Destructive tests made on spot welds include tension, tension-shear, peel, impact, twist, hardness, and macro-etch tests. Fatigue tests and radiography have also been used. Of these methods torsional shear is preferred for round wire and a 45-degree peel test for sheet stock.

Weld Strength Profiles

Creating a weld strength profile offers the user a scientific approach to determining the optimum set of welding parameters and then displaying these parameters in a graphical form.

1 Start at a low weld current, voltage, or power, making five or more welds, then perform pull tests for each weld. Calculate the average pull strength. Increase weld current, voltage, or power and repeat this procedure. Do not change the weld time, weld force, or electrode area.

2 Continue increasing weld current, voltage, or power until any unfavorable characteristic occurs, such as sticking or spitting.

3 Repeat steps 1 through 3 for different weld forces, then create a plot of part pull strength versus weld current, voltage, or power for different weld forces as shown in the illustration on the next page, *Typical Weld Strength Profile*.

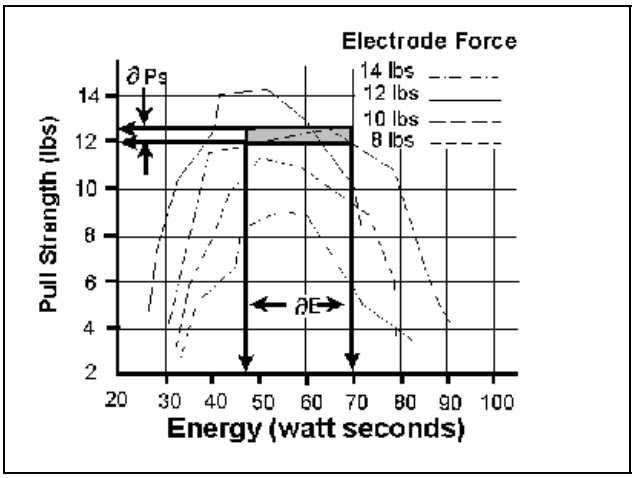
4 Repeat steps 1 through 3 using a different but fixed weld time.

Typical Weld Strength Profile

The picture on the right illustrates a typical weld strength profile. The 14 lb electrode force curve shows the highest pull strengths but the lowest tolerance to changes in weld current, voltage, or power. The 12 lb electrode force curve shows a small reduction in pull strength, but considerably more tolerance to changes in weld energy. Weld heat will vary as a result of material variations and electrode wear.

The 12 lb electrode force curve is preferred. It shows more tolerance to changes in weld current, voltage, or power and has nearly the same bond strength as the 14 lb electrode force curve.

A comparison of weld schedules for several different applications might show that they could be consolidated into one or two weld schedules. This would have obvious manufacturing advantages.



Typical Weld Strength Profile

APPENDIX F

Quality Resistance Welding Solutions: Defining the Optimum Process

Introduction

A quality resistance welding solution both meets the application objectives and produces stable, repeatable results in a production environment. In defining the optimum process the user must approach the application methodically and consider many variables. In this article we will look at the following key stages and principles to be considered when defining the optimum resistance welding process:

- Materials and their properties
- Basic resistance welding
- principles
- Weld profiles
- Approach to development
- Common problems
- Use of screening DOE's
- Use of factorial DOE's

Resistance Welding -- A Material World

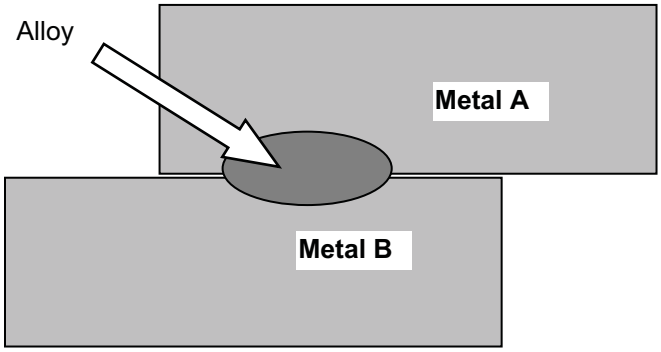
The first consideration in designing a quality welding solution is the properties of the materials to be joined and the quality requirements of the desired welded joint. At this stage, it is worthwhile to review the way the resistance welding process works and the likely outcome when the parts are resistance welded.

There are four main types of structural materials:

- Metals (silver, steel, platinum)
- Ceramic (alumina, sand)
- Plastics/polymers (PVC, teflon)
- Semiconductors (silicon, geranium)

Of these, only metals can be resistance welded because they are electrically conductive, soften on heating, and can be forged together without breaking.

APPENDIX F: DEFINING THE OPTIMUM PROCESS



Alloys are a mixture of two or more metals. An alloy is normally harder, less conductive, and more brittle than the parent metal which has bearing on the type of joint one can expect when resistance welding a combination of different metals.

Metals atoms are naturally attracted to other metal atoms even in different parent materials. Metals and alloys will bond together once surface contaminants such as dirt, grease, and oxides removed. Resistance welding generates heat at the material interface, which decomposes the dirt and grease and helps to break up the oxide film. The resultant heat softens or melts the metal and the applied force brings the atoms on either side into close contact to form the bond. The strength of the joint develops as it cools and a new structure is formed.

There are three main types of bonds that can be formed using the resistance welding process:

- **Solder or Braze Joint**

  A filler material such as a solder or braze compound is either added during the process or present as a plating or coating. Soldered joints are typically achieved at temperatures less than 400°C and brazed joints such as Sil-Phos materials melt at temperatures above 400°C.
- **Solid-State Joint**

  A solid state joint can be formed when the materials are heated to between 70-80% of their melting point.
- **Fusion Joint**

  A fusion joint can be formed when both metals are heated to their melting point and their atoms mix.

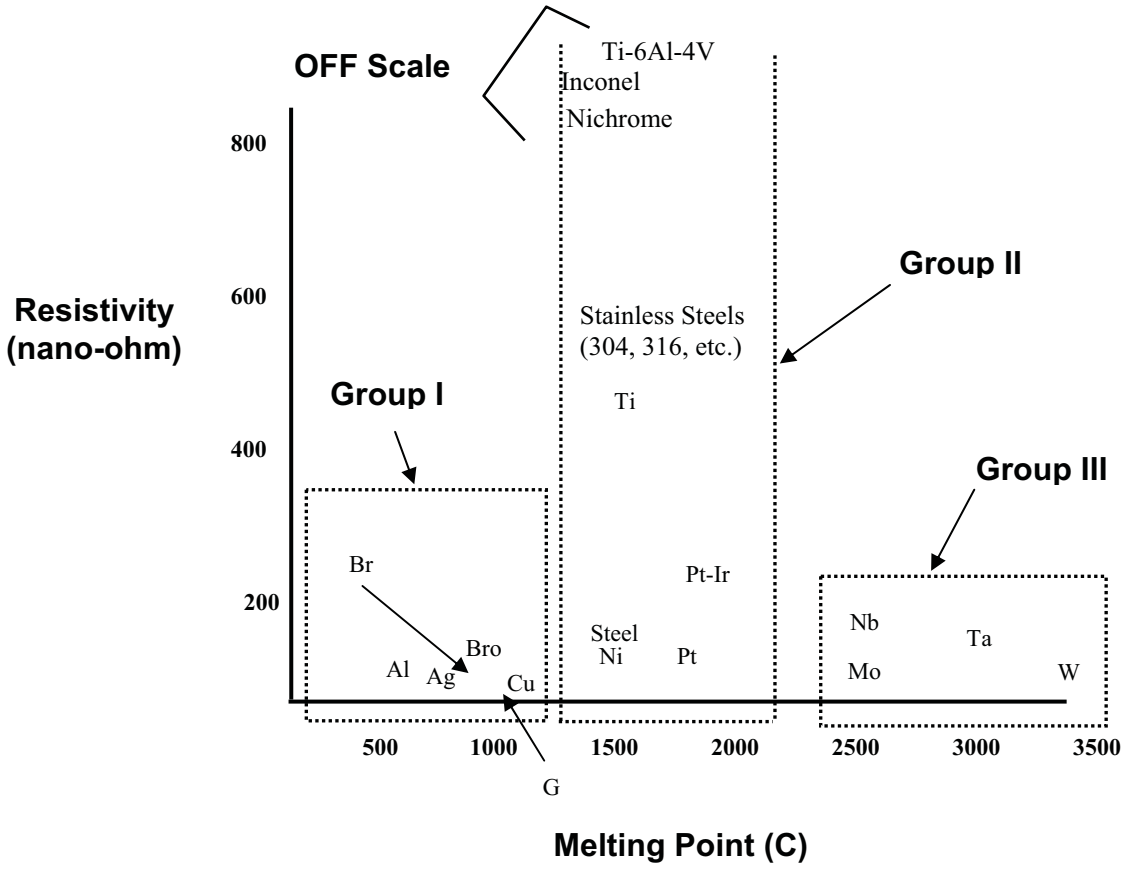
Many micro-resistance welding challenges involve joining dissimilar metals in terms of their melting points, electrical conductivity, and hardness. A solid-state joint can be an ideal solution for these difficult applications; there is no direct mixing of the two materials across the weld interface thus preventing the formation of harmful alloys that could form brittle compounds that are easily fractured. Remember that in a solid-state joint, the metals are only heated to 70-80% of their respective melting points, resulting in less thermal stress during heating and subsequent joint cooling in comparison to a fusion weld. As there is no real melting of the materials in a solid-state joint, there is less chance of weld splash or material expulsion. A weld nugget can still be achieved with a solid-state joint.

Consider the Material Properties

The important material properties to be considered in the resistance welding process are:

- ***Electrical and thermal conductivity***
- ***Plating and coating***
- ***Hardness***
- ***Melting point***
- ***Oxides***

The figure below illustrates the variance in resistivity and melting points for some of the more common materials used in micro resistance welding today.



The materials can be grouped into three common categories. The types of joints achievable within each of the main groups are detailed below:

- **Group I – Conductive Metals**

  Conductive metals dissipate heat and it can be difficult to focus heat at the interface. A solid-state joint is therefore preferred. Typically, resistive electrode materials are used to provide additional heating.

- **Group II – Resistive Metals**

  It is easier to generate and trap heat at the interface of resistive metals and therefore it is possible to form both solid state and fusion welds depending on time and temperature. Upslope can reduce contact resistances and provide heating in the bulk material resistance.

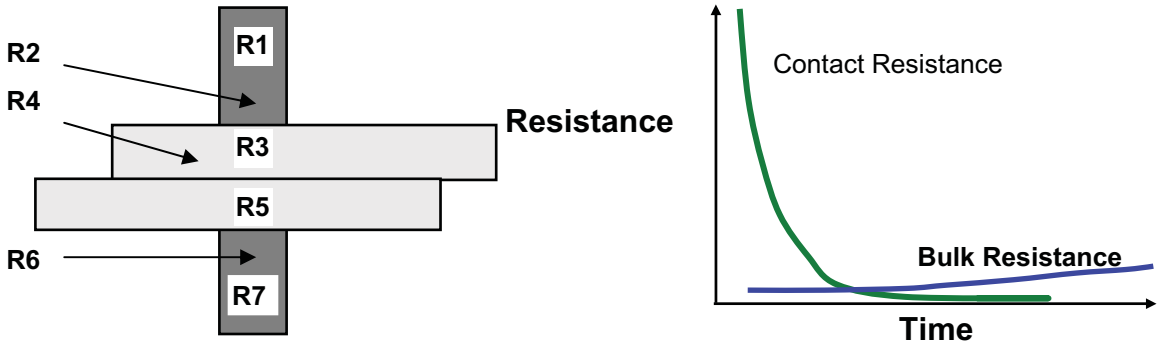
- **Group III – Refractory Metals**

  Refractory metals have very high melting points and excess heating can cause micro-structural damage. A solid-state joint is therefore preferred.

The chart below gives some guidance on the type of joint that can be expected and design considerations required when joining materials from the different groups.

	Group I	Group II	Group III
Group I (Copper)	• Solid-State • W/Mo electrodes	• Solid-State • Projection on Group I	• Solid-State • Fine projections on Group III
Group II (Steel)		• Solid-State or Fusion	• Solid-state or braze of II on III • Projection on III
Group III (Moly)			• Solid-State

Basic Principles



The figure above shows the key resistances in a typical opposed resistance weld and the relationship between contact resistances and bulk resistances over time, during a typical resistance weld:

R1 & R7 The electrode resistances affect the conduction of energy and weld heat to the parts and the rate of heat sinking from the parts at the end of the weld.

R2, R4 & R 6 The electrode-to-part and part-to-part "Contact Resistances" determine the amount of heat generation in these areas. The contact resistances decline over time as the parts achieve better fit up.

R3 & R5 The metal "Bulk Resistances" become higher during the weld as the parts are heated.

If a weld is initiated when the contact resistances are still high, the heat generated is in relation to the level and location of the contact resistances, as the materials have not had a chance to fit up correctly. It is common for the heat generated at the electrode-to-part and part-to-part resistances to cause multiple welding problems when welding resistive materials including:

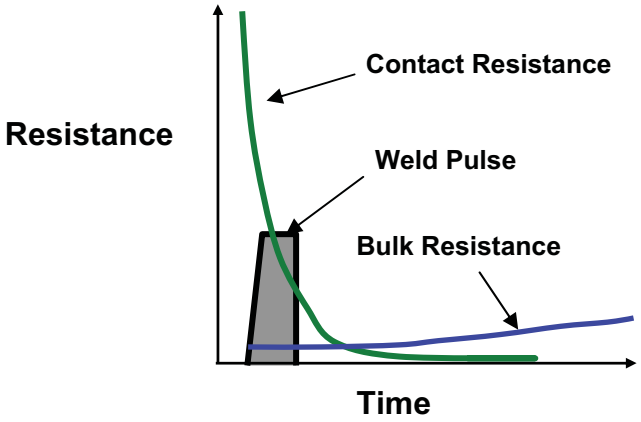
- Part marking and surface heating
- Weld splash or expulsion
- Electrode sticking
- Weak welds

Alternately, conductive materials can be welded by using high contact resistance and fast heating because their bulk resistance is not high and cannot be relied upon for heat generation.

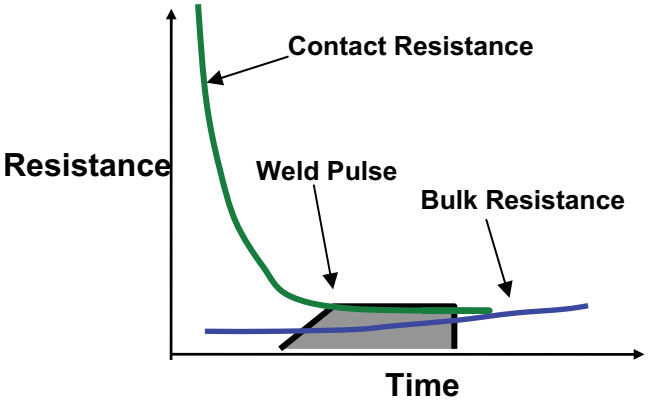
If a weld is initiated when both parts and electrodes are fitted up correctly, the contact resistance is lower and bulk resistance now controls the heat generation. This type of weld is achieved with a slower heating rate and normally longer time is preferred for welding resistive materials, which can generate heat through their bulk resistance.

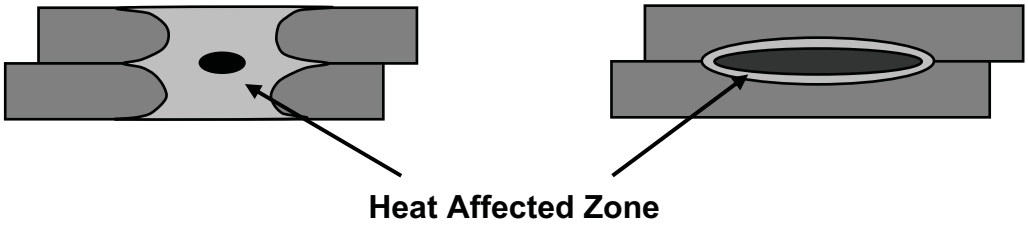
The contact resistances present at the weld when the power supply is fired have a great impact on the heat balance of a weld and, therefore, the heat affected zone.

The figure below shows a weld that is fired early on in the weld sequence when the contact resistance is still quite high.



The figure shows a weld that is initiated when the contact resistance is lower; in this example, we are using bulk resistance to generate our weld heat.

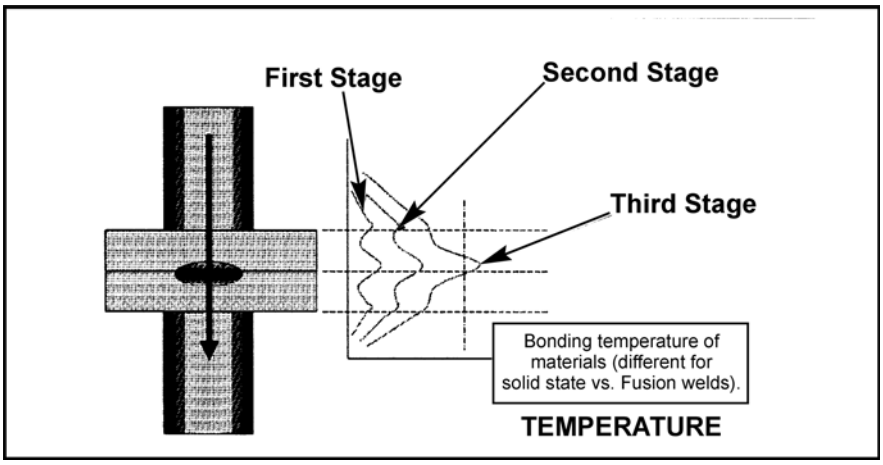




(NOTE: Larger nuggets are possible with longer weld times when using bulk resistance.)

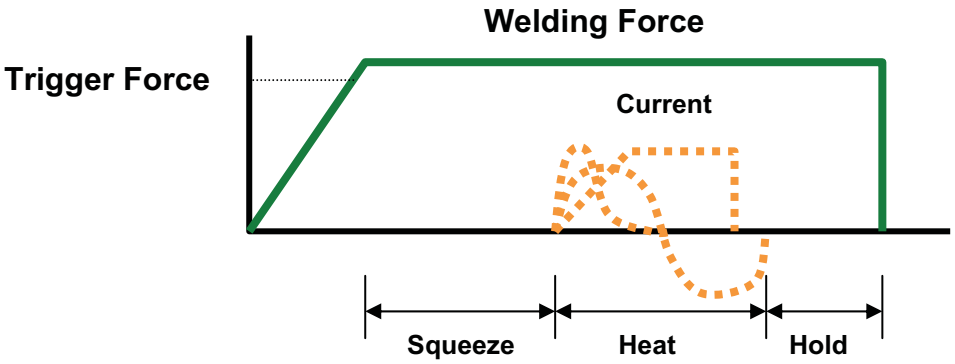
In general, conductive materials benefit from a faster heating rate, as the higher contact resistances assist heat generation in the weld. Resistive materials benefit from slower heating rates which allow the contact resistances to reduce significantly. Bulk resistances, therefore, become the major source for heat generation. The heat-affected zone is also much smaller in this case producing a weld with less variation.

The following figure shows the three stages of heat generation for resistive materials in a fusion weld. In the first stage, the heat is focused in the part-to-part and electrode-to-part contact areas, since contact resistance is high relative to bulk resistance. In the second stage, contact resistance decreases as the electrodes seat better to the parts. Less heat is generated in the electrode-to-part contact areas, and a greater amount of heat is generated in the parts as the bulk resistance increases. In the third stage, the bulk resistance becomes the dominant heat-generating factor and the parts can reach their bonding temperature at the part-to-part interface. The stages of heat generation for conductive materials will be similar to that of resistive materials, but there will be less heat generated in the bulk resistance due to the conductivity of the materials.



Weld Profiles

The basic welding profile (or schedule) consists of a controlled application of energy and force over time. Precision power supplies control the energy and time and therefore heating rate of the parts. The weld head applies force from the start to finish of the welding process.



The figure on the right shows a typical welding sequence where the force is applied to the parts; a squeeze time is initiated which allows the force to stabilize before the current is fired. Squeeze time also allows time for the contact resistances to reduce as the materials start to come into closer contact at their interface. A hold time is initiated after current flows to allow the parts to cool under pressure before the electrodes are retracted from the parts. Hold time is important as weld strength develops in this period. This basic form of weld profile is sufficient for the majority of small part resistance welding applications.

Power supply technology selection is based on the requirements of both the application and process. In general, closed loop power supply technologies are the best choice for consistent, controlled output and fast response to changes in resistance during the weld (for further details comparison see the Unitek Equipment “slide rule” tool).

APPENDIX F: DEFINING THE OPTIMUM PROCESS

Approach to Weld Development

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. The welding variables can be grouped in the following categories:

- **Material Variables**
  - Base material
  - Plating
  - Size
  - Shape
- **Weld Head & Mechanical Variables**
  - Force, squeeze, hold
  - Actuation method
  - Electrode material and shape
- **Power Supply Variables**
  - Energy
  - Time (squeeze, weld, hold)
- **Process Variables**
  - Tooling, level of automation
  - Repetition rate
  - Part positioning
  - Maintenance, electrode cleaning
- **Quality Requirements**
  - Pull strength
  - Visual criteria
  - Test method, other weld joint requirements

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. Welding variables can be grouped in the following categories:

Initial Welding Trials -- The "Look See" Tests

"Look see" welding tests are a series of mini welding experiments designed to provide a starting point for further statistical development of the welding parameters. The user should adjust the key welding variables (energy, force, time) in order to identify the likely good "weld window." Close visual inspection of the weld parts will promote better understanding of the heating characteristics of the application.

The mini-experiments should also be used to understand the weld characteristics from both application and process perspective. Key factors in this understanding are as follows:

Application Perspective

- Materials: Resistivity, melting point, thermal mass, shape, hardness, surface properties.
- Heat balance: Electrode materials, shape, Polarity, heating rate (upslope).
- Observation: visual criteria, cross section, and impact of variables on heat balance.

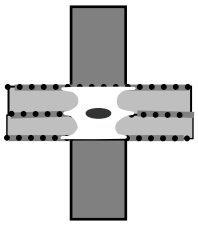
Process Perspective

- What are the likely variables in a production process?
- How will operators handle and align the parts?
- What tooling or automation will be required?
- How will operators maintain and change the electrodes?
- What other parameters will operators be able to adjust?
- What are the quality and inspection requirements?
- What are the relevant production testing methods and test equipment?
- Do we have adequate control over the quality of the materials?

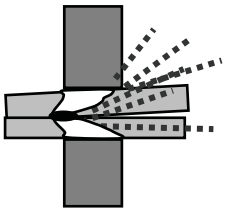
Common Problems

During this stage of process development, it is important to understand that the majority of process problems are related to either materials variation, or part-to-electrode positioning. Some examples are shown below.

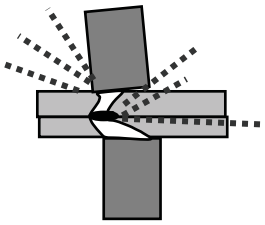
Material Control



Part-To-Part Positioning

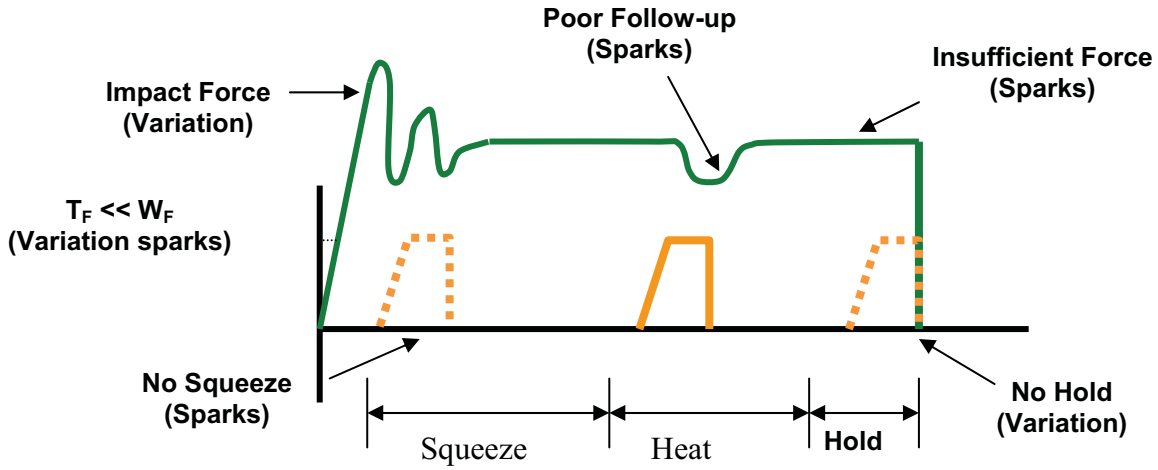


Electrode-To-Part Positioning



The changes detailed above generally result in a change in contact resistance and always affect the heat balance of the weld. During weld development these common problems must be carefully monitored so as not to mislead the course and productivity of the welding experiments.

In summary, the “look see” welding experiments should be used to fix further variables from an application and process perspective and also to establish a “weld window” for energy, time and force. This part of weld development is critical in order to proceed to a statistical method of evaluation (Design of Experiments or “DOEs”). Random explosions or unexpected variables will skew statistical data and waste valuable time.



Common welding problems can often be identified in the basic set up of the force, energy, and time welding profile shown above. These problems can lead to weld splash, inconsistency, and variation (contact Unitek Equipment for further information and support).

What are Screening DOE'S?

The purpose of a Screening DOE is to establish the impact that welding and process parameters have on the quality of the weld. Quality measurement criteria should be selected based on the requirements of the application. A Screening DOE will establish a relative quality measurement for the parameters tested and the variation in the welded result. This is important, as identifying variation in process is critical in establishing the best production settings. Typically, welded assemblies are assessed for strength of joint and variation in strength.

A Screening DOE tests the high, low settings of a parameter, and will help establish the impact of a parameter on the process. A Screening DOE is a tool that allows the user to establish the impact of a particular parameter by carrying out the minimum number of experiments to gain the information. A five-factor screening DOE can be accomplished in as few as 24 welds, with three welds completed for each of 8 tests. By comparison, it would take 96 welds to test every combination. The DOE promotes understanding of many variables in a single experiment and allows the user to interpret results, thus narrowing the variables for the next level of statistical analysis. If many variables are still not understood, multiple Screening DOE's may be required. Unitek Equipment provides a simple Screening DOE tool that is run in Excel® and is sufficient for the majority of possible applications (contact Unitek Equipment for details). Sophisticated software is also available from other vendors designed specifically for this purpose.

Criteria for Success

Before running the series of experiments, the user must establish an acceptable window for energy, time, and force, thus preventing voided results. It is common practice to include one or all of the above variables in a Screening DOE. This is only recommended if sufficient understanding has been established for the other application and process variables that can impact quality Users should first try to screen out all common application and process variables that require further exploration from the results of the "look see" mini experiments and then include the three key welding variables (energy, force and time). Several Screening DOE's may be required.

Results should be interpreted carefully. Typically, one would look for the highest result in terms of quality with the least variation. A Screening DOE provides only a measurement that indicates the relative importance of a parameter and not the ideal setting. Factorial DOE's should be used to establish the correct or best setting for a parameter once many of the other variables have been screened and fixed. This is also the time to assess the measurement accuracy and consistency of the test method and procedure. Variation in test method can invalidate the test and lead to misinterpretation of results.

What are Factorial DOE's?

The purpose of a Factorial DOE is to narrow in on the optimal setting for a particular parameter. This method is generally used when the critical or main key variables have been identified, and we need to establish the best settings for the process. A factorial DOE may also give an indication as to how wide the acceptable weld window is in relation to quality requirements. We recommend data be gathered from a monitoring perspective so that this can provide a starting point for establishing a relationship between quality and the monitored measurement parameter.

Criteria for Success

Critical parameters should be identified from the list of unfixed variables left from the Screening DOE's. A mini-experiment may be required establishing reasonable bounds for the combination of parameters to be tested. This will prevent void data and wasted time. At this stage, it is useful to record multiple relevant quality measurement or inspection criteria so that a balanced decision can be reached. For example, if part marking and pull strength are the relevant criteria, a compromise in ideal setting may be required.

As with all experiments, the test method should be carefully assessed as a potential source of variation and inconsistency. Once the optimum parameters have been established in this series of experiments, a validation study can be run which looks at the consistency of results over time. It is good practice to build in variables such as electrode changes and cleaning, as well as equipment set up by different personnel. This will ensure that the solution is one that can run in a real production environment. Welded assemblies should be tested over time and under real use conditions to ensure that all functional criteria will be met. Validation testing is usually required to prove the robustness of the process under production conditions.

Conclusion

The resistance welding process can deliver a reliable and repeatable joining solution for a wide range of metal joining applications. Defining the optimum welding process and best production settings can be achieved through a methodical and statistical approach. Time spent up front in weld development will ensure a stable welding process and provide a substantial return in quality and long term consistency. Welding problems can more easily be identified and solved if sufficient experimental work is carried out to identify the impact of common variables on the quality and variation of the welded assembly. Unitek Equipment frequently uses the Screening DOE tool to establish the impact of key variables and to assist customers with troubleshooting. Often, the testing described above will provide the information and understanding to predict common failure modes and causes. A troubleshooting guide can be requested in the form of a slide rule, to assist users in identification of welding problems and likely causes.